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We heartily congratulate Dr Imre Máthé, academician,
member of the Editorial Board, on the occasion of his 70th birthday

MCPA INDUCED TISSUE CHANGES IN SUNFLOWER (*HELIANTHUS ANNUUS* L.) LEAVES

By

F. HERDI

RESEARCH INSTITUTE FOR PLANT PROTECTION BUDAPEST

Tissue changes caused by 100, 1000 and 5000 ppm concentrations of MCPA were studied in the leaf blade of sunflower at three stages of plant development. With a view to evaluating the effects of MCPA the thickness of the leaf blade, the lengths of the palisade and spongy parenchyma cells, and the wall thickness of the epidermis cells were measured. The number of cell rows in the palisade and spongy parenchyma was also recorded. On the third occasion of sampling the leaf blade was found to have become considerably thinner in response to 100 ppm, and essentially thicker in response to 1000 ppm MCPA. When MCPA was applied at a concentration of 5000 ppm it caused a thinning of the leaf blade in the second sample compared to both the first sample and the control. The lengths of the palisade and spongy parenchyma cells were sharply reduced. The thickness of the epidermis cell walls decreased on both sides of the leaf to a considerable extent under the influence of the herbicide.

Introduction

In the chemical weed control of cereals hormone-based herbicides are used in large volumes. They are mostly distributed from aeroplanes or helicopters and may thus cause damage or destruction to crops sensitive to hormone-based herbicides. Both above- and below-ground plant parts may be damaged by them; the damage appears in the form of deformation. In the aboveground parts distortion, twisting or fasciation of the stems occur. The leaves become funnel-like (BUHL 1958, UBRIZSY 1962), or grow together (WAY 1962, 1963b, 1964a; Kiermayer cit. AUDUS 1964); the vine shows "fanleaf" or "ginkgo leaf" symptoms (UBRIZSY 1962, SZATALA 1967) and other anatomical modifications (Andersen, Bachthaller, Fiedler, Hanf cit. UBRIZSY 1962, TERPÓ-POMOGYI—TERPÓ 1971). Other leaf deformations were also observed by WAY (1963a, 1963c, 1964b). The fruit displays intense distortion (UBRIZSY 1962). Roots may also suffer considerable damage (BUHL 1958, WAY 1962, 1963a, 1963b, 1964a). UBRIZSY (1962) observed high sensitivity to hormonal herbicides in sunflower and tobacco.

The greatest injury occurs in the leaf at the time of cell differentiation; if it is slightly younger, or fully developed the treatment does not cause much damage (WATSON 1948). An excessive multiplication of cells in the meristematic tissues and the transporting phloem elements of the stem was observed by EAMES (1951). These herbicides have a great influence on the development of

the cell wall too (Gorter, Gifford cit. AUDUS 1964). The cells of the palisade parenchyma become larger in all directions, mainly longitudinally (WATSON 1948). The increase in the length of palisade parenchyma cells causes a thickening of the leaf (Bradley et al. cit. AUDUS 1976). The cells of the spongy parenchyma also become deformed as a result of treatment with hormonal herbicides (Haccius cit. AUDUS 1964). Under the influence of 2,4-D the leaf veins protrude to a considerable extent (FELBER 1948, WATSON 1948). The vascular bundles of the leaf are close to one another (EAMES 1949, WATSON 1948).

Material and method

The experiment was carried out with sunflower (variety: Vniimk 6541). The plants were sown on 12th May 1978 and were treated on 12th June, when they had reached a height of 12 cm. The herbicide, which consisted of MCPA of technical purity (2-methyl-4-chlorophenoxy-acetic acid), was applied in the form of a spray. The treatments were:

MCPA	100 ppm
MCPA	1000 ppm
MCPA	5000 ppm
Control	(no treatment)

Samples were taken on three occasions:

1. 14th June
2. 21st June
3. 11th July

When MCPA was applied at a concentration of 5000 ppm it destroyed the treated plants, so only samples 1 and 2 could be evaluated. The samples were taken in the morning and fixed in 40% alcohol. The sections were made from the middle of the leaf by means of an MC-2 slide microtome furnished with a KTOC-2 electric freezer. For staining the sections Ehrlich's acidic hematoxilin was used.

For the mathematical evaluation of the experiment measurements were taken of the thickness of the leaf blade, the thickness of the epidermis cell walls on the upper and lower surfaces of the leaf, and the lengths of the cells in the palisade and spongy parenchyma. The number of cell rows in the palisade and spongy parenchyma was also recorded. The data thus obtained were evaluated by the double t-test.

Results

Tissue changes in the treated plants compared to the control are shown in Figs 1—3, with three samples for each of the three concentrations of MCPA. Plants treated with 5000 ppm MCPA were destroyed by the time the third sample was taken, so data for the latter are missing.

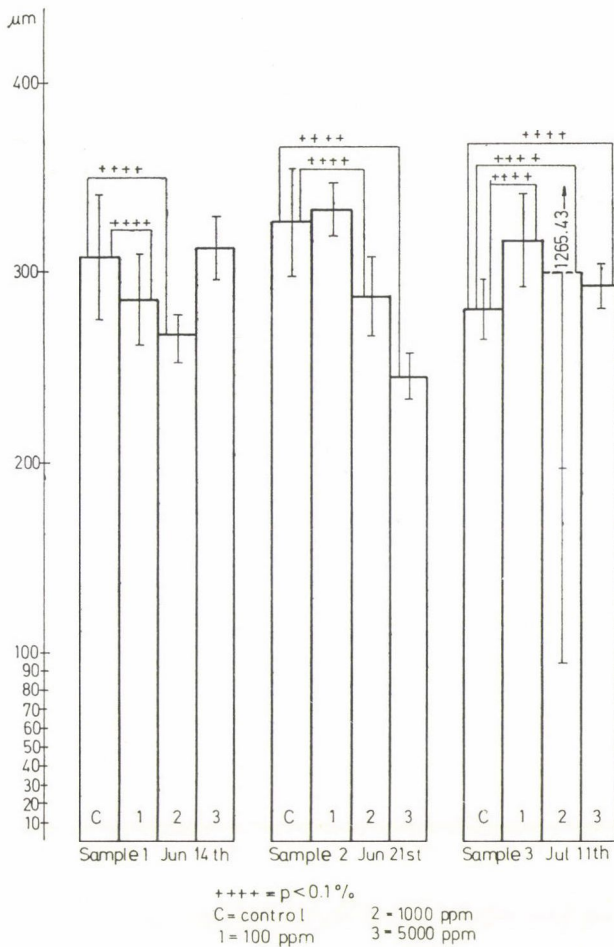


Fig. 1. Changes in leaf thickness in response to treatment with MCPA

Examination of control leaves

Sample 1 (taken on 14th June). The leaf is bifacial (Fig. 4A); there are stomata in the epidermis on both sides of the leaf. The palisade parenchyma is 2 cell-rows wide; the cells are elongated, not close-set (Fig. 5A). The length of the cells is 2—3 times their width. The spongy parenchyma is 2—3 cell-rows wide, with loosely set cells of irregular shape (Fig. 5G). The main leaf veins are only slightly protruded. The leaf is of even thickness; the epidermis on both sides is free from protrusions and depressions.

Sample 2 (taken on 21st June). The arrangement of cells in the palisade and spongy parenchyma (Fig. 4B) is similar to that found in sample 1. There

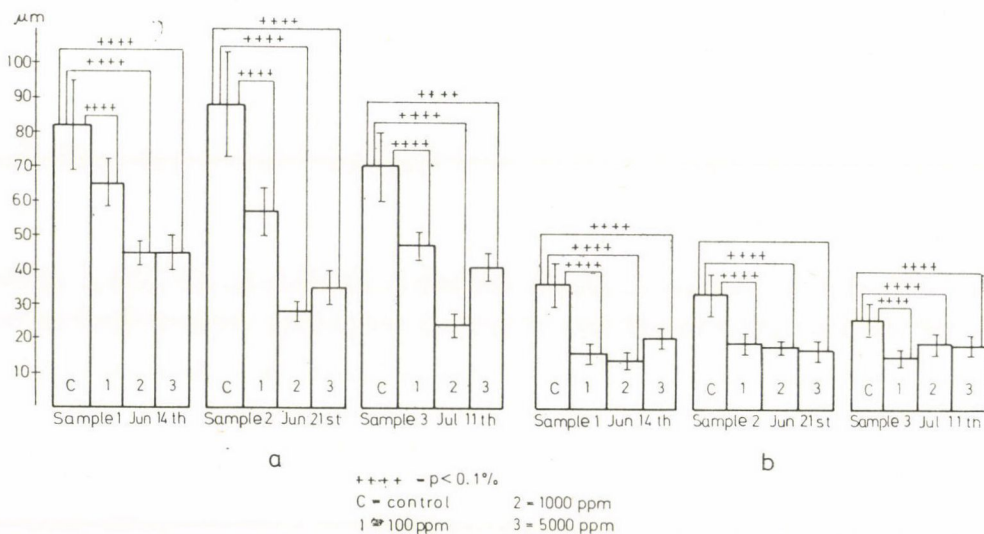


Fig. 2. a) Changes in the length of palisade parenchyma cells in response to treatment with MCPA. b) Changes in the length of spongy parenchyma cells in response to treatment with MCPA

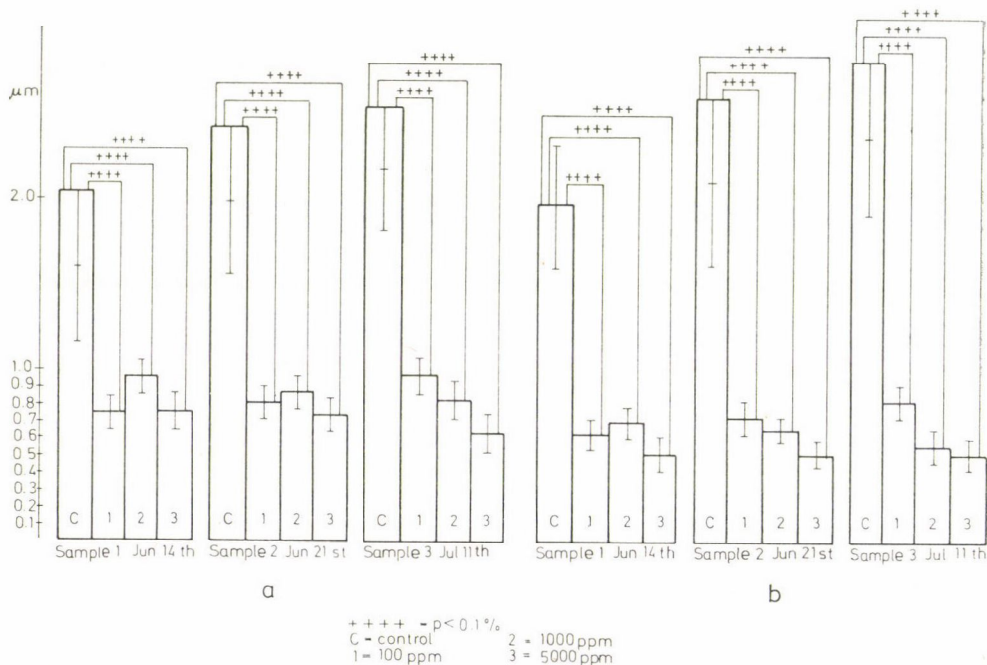


Fig. 3. a) Changes caused by MCPA in the thickness of epidermis cell walls on the upper leaf surface. b) Changes caused by MCPA in the thickness of epidermis cell walls on the lower leaf surface

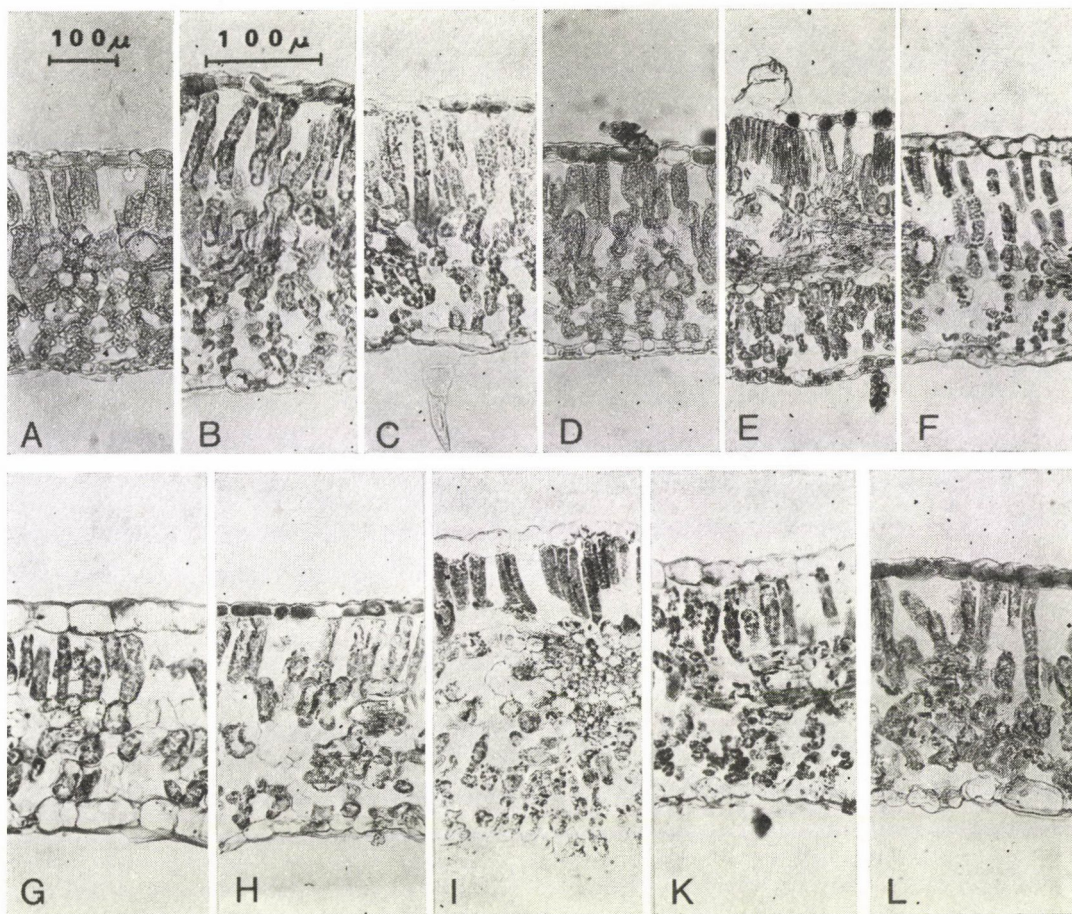


Fig. 4. Cross-section of leaves in the control and MCPA-treated plants (A—C = control; D—F = 100 ppm; G—I = 1000 ppm; K—L = 5000 ppm; A, D, G, K = sample 1 (taken on 14th June); B, E, H, L = sample 2 (taken on 21st June); C, F, I = sample 3 (taken on 11th July)]. Figures A, D and E are on the same scale, as are figures B, C, F, G, H, I, K and L)

are 2 cell-rows in the palisade parenchyma and 2—3 in the spongy parenchyma (Fig. 5H). The palisade parenchyma cells are somewhat elongated (Fig. 5B); they are 3—4 times longer than they are wide. The leaf blade is of even thickness; the epidermis on both sides is similar to that in sample 1.

Sample 3 (taken on 11th July). Cells in the palisade and spongy parenchyma are arranged in the same way as in sample 1 (Fig. 4C). There are 2 rows in the palisade parenchyma (Fig. 5C) and 2—3 rows in the spongy parenchyma (Fig. 5I). The cells of the palisade parenchyma are slightly elongated; their length is some 4—5 times their width. The leaf is of even thickness; the upper and lower epidermises are similar to those in sample 1.

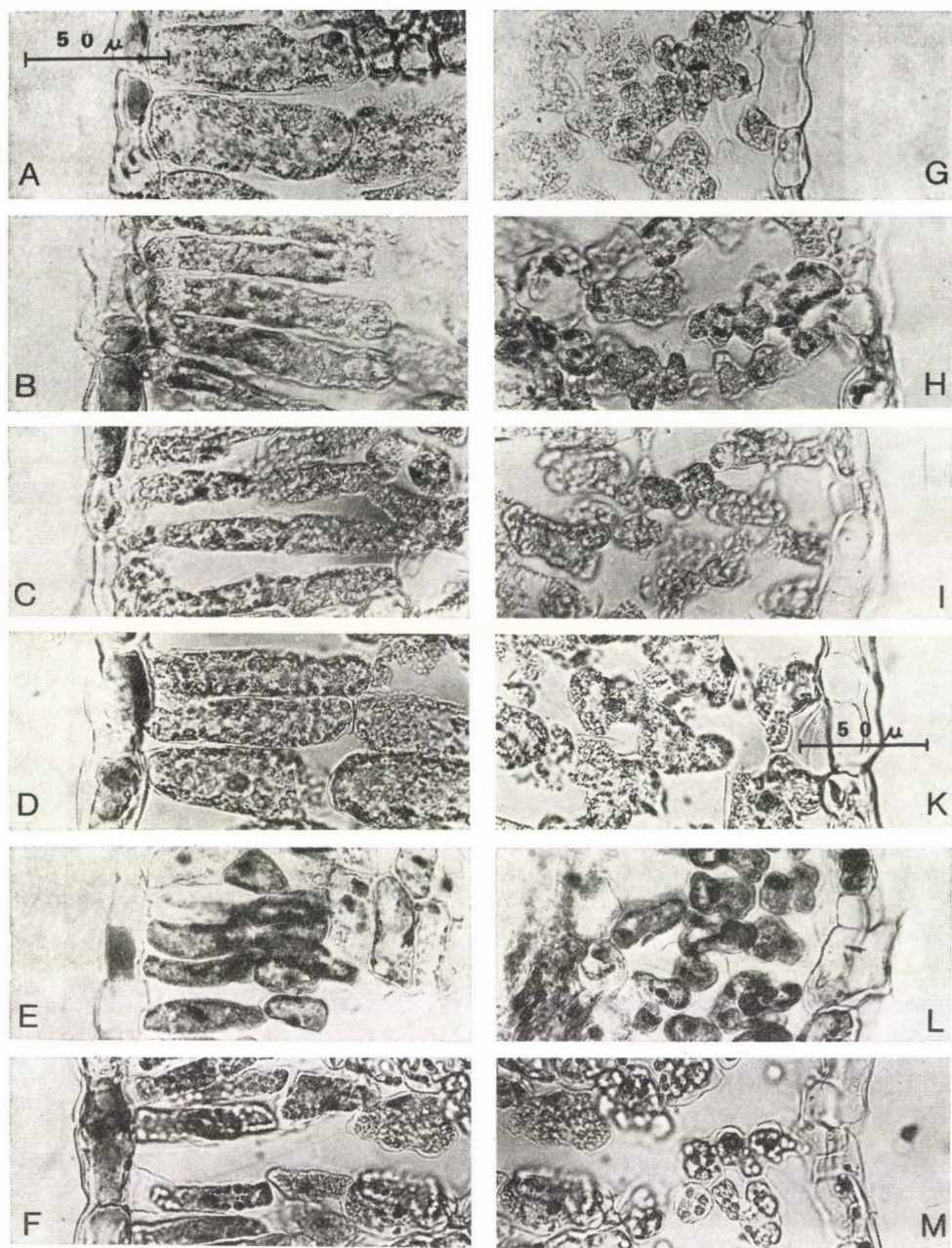


Fig. 5. Palisade and spongy parenchyma cells in the leaves of control plants and in leaves treated with 100 ppm MCPA [A—F = palisade parenchyma cells; A—C = control; D—F = 100 ppm; G—M = spongy parenchyma cells; G—I = control; K—M = 100 ppm; A, D, G, K = sample 1 (taken on 14th June); B, E, H, L = sample 2 (taken on 21st June); C, F, I, M = sample 3 (taken on 11th July)]. Figures A, B, C, D, E, G, H, I and L are on the same scale, as are figures D, F, K and M

Structural analysis of leaves treated with MCPA

Effect of 100 ppm

Sample 1 (taken on 14th June). The palisade parenchyma (Fig. 5D) is 1—2 cell-rows wide (Fig. 4D). Cells towards the middle of the mesophyll are shorter than those below the epidermis; their length is 1—2 times their width, while the cells nearer the epidermis are 2—3 times longer than they are wide. The cells are not close set. Cells in the spongy parenchyma (Fig. 5K) are round, oval, or of irregular shape, loosely arranged in 3—4 rows (Fig. 4D). The leaf is of even thickness; the epidermis on both sides is free from protrusions and depressions. The leaf blade shows changes compared to the control, being considerably thinner (Fig. 1); cells in the palisade parenchyma are moderately shorter, while those in the spongy parenchyma are much shorter than the cells of the control (Fig. 2). As regards the thickness of the cell walls in the epidermis on both sides of the leaf, the sample differs from the control quite noticeably (Fig. 3): the cell walls are notably thinner.

Sample 2 (taken on 21st June). The palisade parenchyma is 1—2 cell-rows wide (Fig. 5E). Cells nearer the epidermis are elongated, with a length 3—4 times their width, while those nearer the mesophyll are shorter, being only 2—3 times longer than they are wide. The cells are closer set than in sample 1. The spongy parenchyma cells are arranged in 2—3 loose rows (Fig. 5L); they are round, oval, or of irregular shape. The leaf is not so even in thickness as in sample 1. Protrusions and depressions are found mainly on the lower leaf surface; on the upper surface this symptoms is much less conspicuous. The leaf blade is somewhat thicker than in the control (Figs 1 and 4E). The cells of the palisade parenchyma differ greatly in length from the control, while those of the spongy parenchyma differ to a lesser extent (Fig. 2); in both cases they are shorter. The thinning of the cell walls in both the upper and lower leaf epidermis is very noticeable (Fig. 3).

Sample 3 (taken on 11th July). The palisade parenchyma is 1—2 cell-rows wide (Fig. 5F). Cells nearer the epidermis are considerably elongated, being 4—5 times longer than they are wide; those nearer the mesophyll are much shorter, their length being 2—3 times their width. The cells are arranged loosely in rows. The spongy parenchyma (Fig. 5M) is 3—4 cell-rows wide; the cells are round, oval, or of irregular shape and are loosely set. The thickness of the leaf blade is uneven; protrusions and depressions are hardly perceptible on the upper surface, but are found in considerable numbers on the lower surface of the leaf. The leaf blade is thin compared to the control, as in sample 1, though the extent of thinning is even greater here (Figs 1 and 4F). The difference in length compared to the control is much greater for the cells

of the palisade parenchyma than for those of the spongy parenchyma (Fig. 2); in both cases the cells are shorter than in the control. The epidermis cell walls are extremely thin compared to the control (Fig. 3).

Effect of 1000 ppm MCPA

Sample 1 (taken on 14th June). The palisade parenchyma consists of a single row of cells which are not closely set (Fig. 6A). The cells are 3–4 times longer than they are wide. The oval or irregular cells of the spongy parenchyma are arranged in 2–3 loose rows (Fig. 6F). The leaf blade is of even thickness with minor protrusions and depressions only on the lower leaf surface; it is much thinner than the control leaf (Figs 1 and 4G). The cells of the palisade and spongy parenchyma are noticeably shorter than the corresponding cells of the control (Fig. 2). The walls of the epidermis cells on both sides of the leaf blade are considerably thinner than those of the control (Fig. 3).

Sample 2 (taken on 21st June). The palisade parenchyma (Fig. 4H) is 1–2 cell-rows thick (Fig. 6B). The cells nearer the epidermis are shorter than in sample 1, their length being 2–3 times their width, while the cells nearer the mesophyll are only twice as long as they are wide. The cells are closer set than in sample 1. The spongy parenchyma consists of 3–4 rows of oval, irregular, or round, loosely set cells (Fig. 6G). The leaf blade is of even thickness with larger or smaller protrusions and depressions only on the lower leaf surface. The thinning of the leaf blade compared to the control is of greater extent than in sample 1 (Figs 1 and 4H). The cells of the palisade and spongy parenchyma differ more in length from the corresponding cells of the control than in sample 1 (Fig. 2). The cell walls of the epidermis are noticeably thinner than in the control (Fig. 3) on both sides of the leaf, though more so on the lower leaf surface.

Sample 3 (taken on 11th July). The cells of the palisade parenchyma (Fig. 6C) are arranged in a single row, or sometimes in 2 rows. Cells in the outer row are highly varied in shape. Some are 2–3 times, others 4–5 times longer than they are wide. Cells nearer the mesophyll are very short, only 1–2 times longer than they are wide. The cells are set loosely in rows. The spongy parenchyma consists of 4–5 rows of loosely set, oval, irregularly shaped, or sometimes round cells (Fig. 6H). The leaf blade is not of even thickness, with large protrusions and depressions on both sides; it is much thicker than that of the control (Figs 1 and 4I). The cells of the palisade and spongy parenchyma are shorter than the corresponding cells of the control, though there is not a great difference in length (Fig. 2). The cell walls of the epidermis on both sides of the leaf are extremely thin compared to the control (Fig. 3).

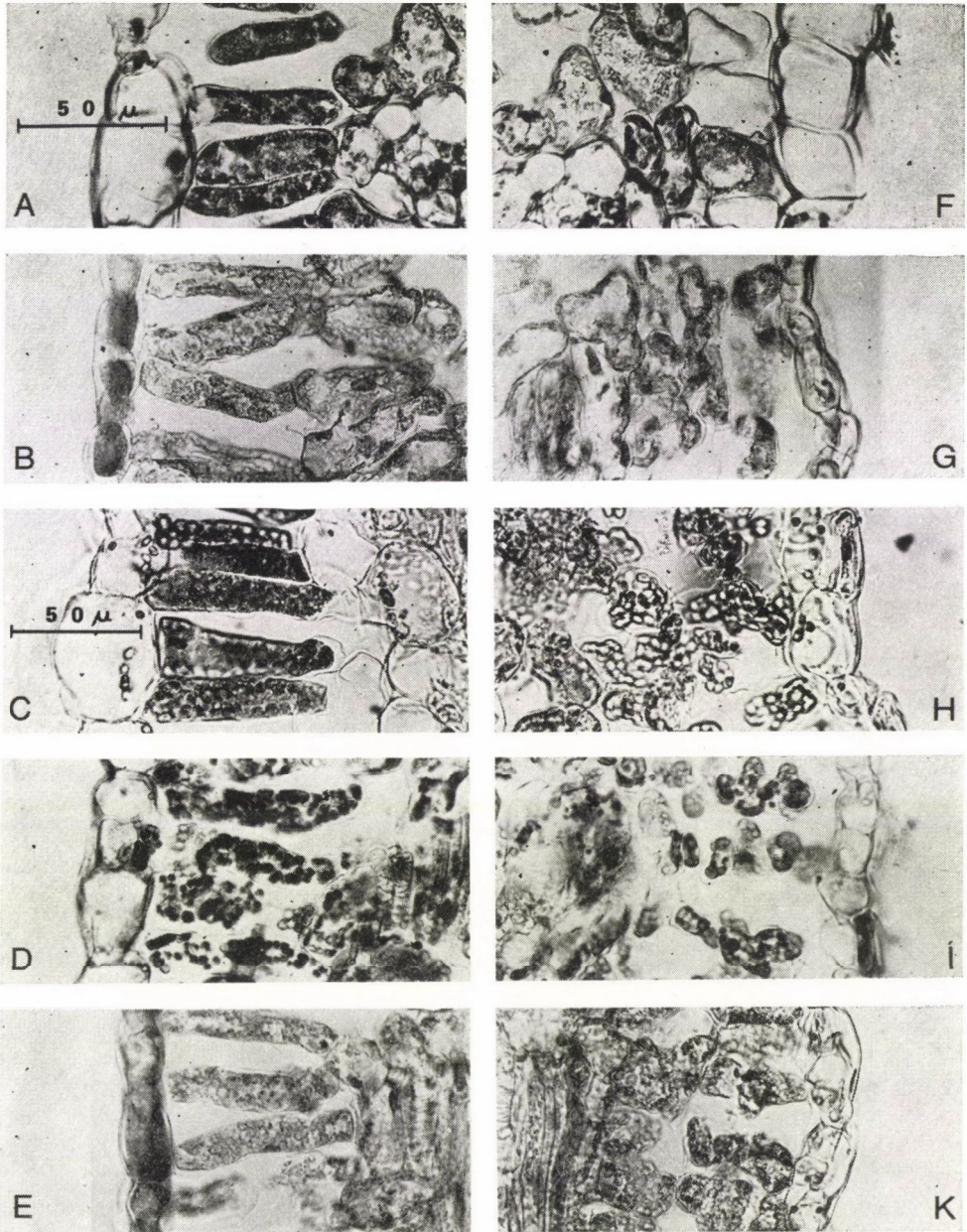


Fig. 6. Palisade and spongy parenchyma cells in the leaves of plants treated with 1000 and 5000 ppm [A—E = palisade parenchyma cells; A—C = 1000 ppm; D—E = 5000 ppm; F—K = spongy parenchyma cells; F—H = 1000 ppm; I—K = 5000 ppm; A, D, F, I = sample 1 (14th June); B, E, G, K = sample 2 (21st June); C, H = sample 3 (11th July)].

Figures A, B, D, E, F, G, I and K are on the same scale, as are figures C and H

Effect of 5000 ppm MCPA

Sample 1 (taken on 14th June). The palisade parenchyma (Fig. 6D) consists of 1–2 rows of loosely arranged cells. Cells in the outer row are 2–3 times, and those nearer the mesophyll twice as long as they are wide. The cells of the spongy parenchyma (Fig. 6I) are round, oval or of irregular shape, arranged in 4–5 loose rows. The thickness of the leaf blade is even; minor protrusions and depressions are only found on the lower surface. As regards the thickness of the leaf blade, the sample differs only slightly from the control (Figs 1 and 4K). The cells of the palisade and spongy parenchyma considerably differ in length from the corresponding cells of the control (Fig. 2). The wall thickness of the epidermis cells on both sides of the leaf is greatly reduced compared to the control (Fig. 3); the difference in thickness is greater on the lower leaf surface.

Sample 2 (taken on 21st June). The cells of the palisade parenchyma (Fig. 6E) are arranged in 1–2 rows. The cells nearer the epidermis are 3–4 times as long, and those adjacent to the mesophyll 2–3 times as long as they are wide. They are set loosely. The spongy parenchyma (Fig. 6K) consists of 3–4 rows of loosely arranged oval, irregular, or sometimes round cells. Here and there slightly elongated, oblong cells are also found, resembling the palisade parenchyma cells adjacent to the mesophyll. The thickness of the leaf blade is more or less uniform, minor protrusions and depressions only being found on the lower leaf surface. The leaf blade is much thinner than in the control (Figs 1 and 4L), but the difference in thickness is slight compared to the previous sample. The palisade parenchyma cells do not differ greatly in length compared to those in the 100 and 1000 ppm treatments, but they are noticeably shorter than in the control (Fig. 2). The cells of the spongy parenchyma are considerably shorter than the corresponding cells of the control (Fig. 2). The walls of the epidermis cells on both the upper and lower surfaces of the leaf are extremely thin compared to the control (Fig. 3). This symptom is particularly noticeable on the lower leaf surface.

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EFFECT OF PLANTING DEPTH ON THE REGENERATION OF RHIZOMES IN SORGHUM HALEPENSE (L.) PERS

By

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The regeneration of 7-node decapitated rhizome segments of *Sorghum halepense* planted 2.5, 5, 10 and 15 cm deep was studied. It was found that the first shoots of rhizome segments placed at various depths reached the soil surface on the 15th to 27th day after planting. With an increase in the depth of planting the time required for regeneration became longer and the number of shoots fewer. Apical dominance was characteristic of the rhizome segments whatever the depth of planting. The optimum depth of planting for the regeneration of the rhizomes was 2.5-5 cm, when the number, length and fresh weight of the shoots were the highest. With a planting depth of 10 cm, 16% of the shoots developing from activated axillary buds had not reached the soil surface by the completion of the experiment (after 44 days); with the 15 cm depth of planting this proportion was more than threefold (50%). This means that from a depth of 15 cm the rhizomes regenerate with great difficulty. The data of the experiment give a clue to the best method of soil cultivation. If the rhizomes cut up are ploughed deeper than 15 cm into the soil a high percentage of the shoots developing from the buds will only reach the soil surface slowly, if at all, so they will be less competitive, which makes them easier to control.

Introduction

The germination of rhizome buds in *Sorghum halepense* (L.) has been studied by many authors, and apical dominance has been the main subject of investigation (HULL 1970, BEASLEY 1970). A report on the apical dominance manifest in the growth of rhizomes was first given in connection with the germination of rhizome buds in quackgrass [*Agropyron repens* (L.) B.P.] by JOHNSON-BUCHHOLTZ (1961) and VENGRIS (1962). The results of investigations made by HULL (1970) and BEASLEY (1970) suggest that the development of rhizome buds is controlled by apical dominance in the case of Johnson-grass as well. McWHORTER (1972) studied the effects of various soil types and rhizome lengths on the germination of rhizomes placed at different depths. HUNYADI (1978) studied the regeneration process of *Agropyron repens*. With no detailed data available on the regeneration of *S. halepense* an experiment was begun with rhizome segments of average length (7 nodes). Our aim was to clarify the details of the regeneration process of rhizome segments.

Material and method

The experiment was carried out with 7-node decapitated rhizome segments obtained from the *S. halepense* stock of the Baja Agricultural Combine at Mátéháza. The experiment was set up in the field on 27th April. Under normal conditions the growth and sprouting of rhizome segments begin at Baja at the end of March or beginning of April. The reason the experiment was started later was to eliminate the harmful effects of low temperatures or possible frosts. Temperatures of air and soil (in the 2—20 cm layer) during the experiment are presented in Fig. 3. Three pits each 60×45×30 cm in size were dug on the experimental site and the soil was sieved so that it was small-grained. The rhizome segments were planted horizontally at depths of 2.5, 5, 10 or 15 cm. Three rhizome segments were placed at each depth in three replications. The experiment was laid out in a random block design. A wire ring furnished with a number was placed on each above-ground shoot developing from the rhizome segments on the day of emergence, so that the rate of regeneration could be followed. The experiment lasted 44 days, until the end of regeneration. During this period the above-ground length of the shoots was measured daily. At the end of the experiment the rhizome segments were removed from the soil, the position of the shoots on the rhizomes was established and the fresh weight of the shoots was measured, as well as the number and length of the shoots that did not reach the soil surface.

Results

The daily rate of sprouting and the total number of shoots emerging from different depths are shown in Fig. 1. The first shoots appeared on the 15th, 17th, 26th and 27th days after planting from depths of 2.5, 5, 10 and 15 cm, respectively. The difference in emergence time between rhizomes planted 2.5 and 15 cm deep was 12 days. The percentage number of shoots which came up decreased parallel with the increase in planting depth.

Position of dominant shoots on rhizome segments: The dominant shoot was found without exception in the apical zone (Fig. 2).

Shoot production of rhizome segments: The lengths and weights of the shoots developing from the rhizomes are contained in Table 1.

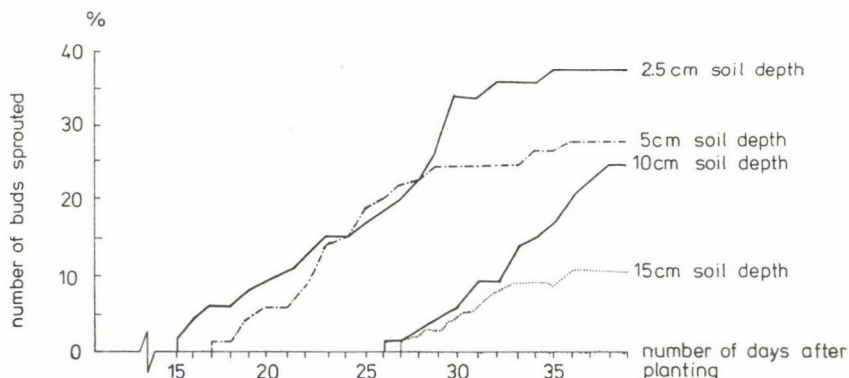


Fig. 1. Percentage number of buds sprouting from various depths of soil, Baja, 1978

Table 1
Shoot production of rhizome segments
 Baja, 1978

Depth of planting (cm)	Average length of shoots (cm)	Total fresh weight of shoots (g)	Average fresh weight of one shoot (g)
2.5	889.1	504.0	21
5	771.0	501.5	27.9
10	542.7	310.5	19.4
15	239.8	157.5	22.5

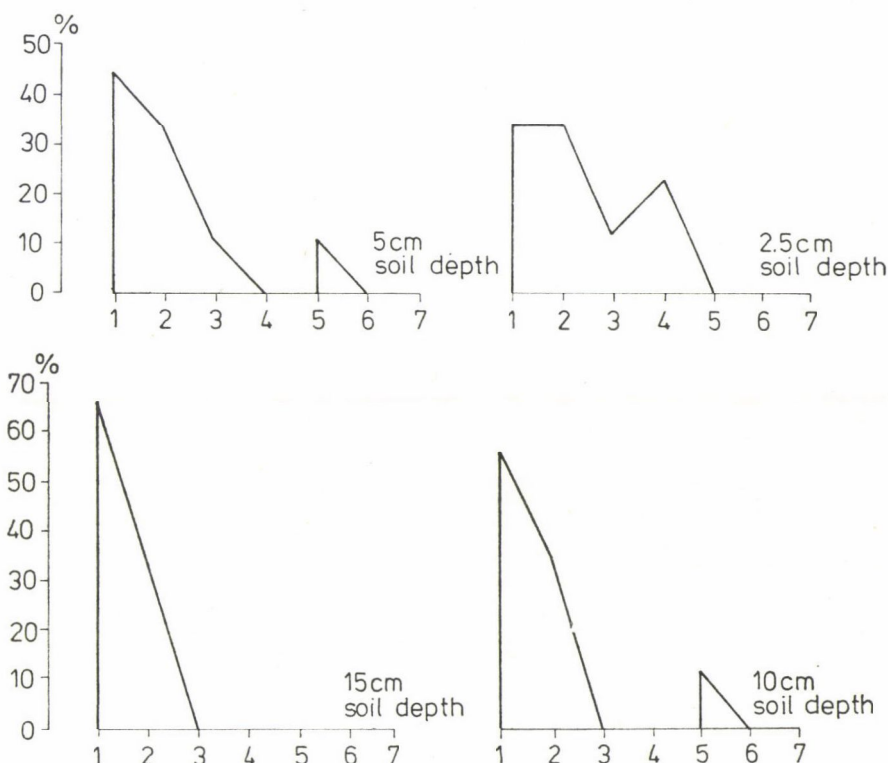


Fig. 2. Position of the dominant shoot on the rhizome. Baja, 1978

As shown in the table, the optimum zone for the regeneration of rhizome segments is in the 2.5–5 cm soil layer. This is also verified by the height and weight data of the shoots.

Mortality and rhizome formation of shoots: In the case of rhizome segments planted at a depth of 10 cm, 16% of the shoots developing from

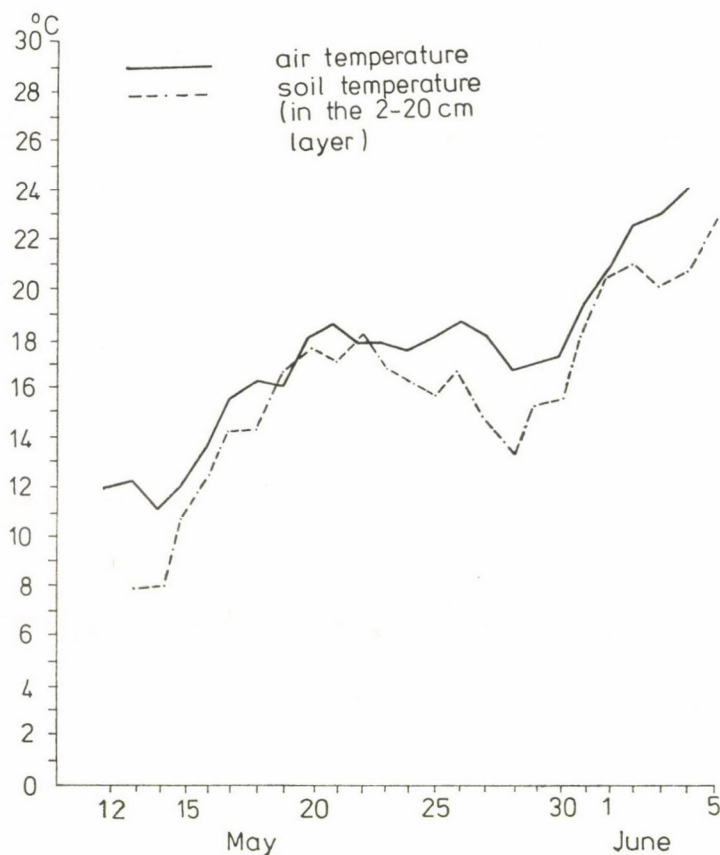


Fig. 3. Mean temperatures of air and soil between 12th May and 5th June 1978

activized axillary buds had not reached the soil surface by the completion of the experiment (after 44 days). For the 15 cm planting depth this proportion was 50%. The average length of these shoots was 4 cm from a depth of 10 cm, and 10 cm when the depth of planting was 15 cm. These shoots were also healthy. New branching was not observed on the rhizome segments. Similar results were obtained by HOROWITZ (1973), according to whom rhizome segments form new rhizomes 6–8 weeks after planting.

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STUDIES OF FACTORS INFLUENCING THE NUTRITIONAL VALUE, PALATABILITY AND TOXICITY OF DIFFERENT LUPINE SEEDS

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Seed samples of five lupine species, namely *Lupinus albus* "sweet I", *L. albus* "revertant bitter", *L. albus* "commercial bitter", *L. albus* "sweet II", and *L. luteus* "HD-7", were analysed for constituents, minerals and biologically active components, and were tested in rat feeding experiments by addition to the basal rat feed in ground form, at 25% dietary level. Analysis for biologically active components covered the quantitative determination of alkaloids, tanning agents, haemolytic saponine and trypsin inhibitor activity. The crude protein (37–45%) and crude fat (6.4–11.2%) contents of the lupine seeds were generally advantageously high. The iron content of the seeds was generally low, while the manganese content was generally high (950–1260 mg/kg). The two "bitter" varieties, *L. albus* "commercial bitter" and *L. albus* "revertant bitter" had high alkaloidal contents, which depressed the weight gain of the rats in the feeding experiments. The other three lupine varieties caused no notable depression of weight gain. Post mortem, pathohistological, and electron microscopic examinations performed after extermination of the rats at the conclusion of the experiment revealed no gross, microscopic, or ultrastructural lesion attributable to lupine with any variety tested. On the basis of the experimental observations three of the five lupine varieties examined seem to be suitable for use as a protein source at a 25% dietary concentration in fodder diets of domestic animals.

Introduction

Lupine poisoning has long been known in Hungary as a dietary toxicosis causing hepatic symptoms in certain animal species fed on lupine seeds.

Most authors have attributed lupine poisoning to the alkaloidal contents of the seeds (BAILEY *et al.* 1974, BAINTEY 1967, BECKER—NEHRING 1965, CSUKÁS 1956, KAPP 1977), but some investigators (CRANE 1973) have incriminated the extraordinarily high mineral content of lupine seeds as the primary causal factor. The high iron content of lupines (GARDINER 1961, 1965, 1966) has been held responsible for developmental abnormalities of the foetus (SHUPE *et al.* 1967) of pregnant ewes and cows fed lupine seeds or seed extracts in different stages of gestation. Ruminants with lupinosis showed an increase in the serum cholinesterase level simultaneously with the hepatic symptoms (JAMES *et al.* 1968).

Recently lupine species or varieties with low alkaloid contents have been increasingly considered for use in fodder diets as a protein source instead

of soya beans, for economic reasons, since they can be cheaply and safely grown in acid sandy soils and eroded forest soils. Attempts have therefore been made to develop by selection and refinement so-called "sweet lupine" varieties with low alkaloidal contents (generally less than 0.1%). In Hungary, the soya protein component has so far been replaced by sweet lupine seeds in 10% of the commercial pig feeds, but more extensive use is still hampered by palatability problems.

Many authors have analysed lupine seeds for nutritional value and applicability in commercial fodder diets (BECKER—NEHRING 1965). It was found that the consumption of lupine seed meal, added to the diet at 12% concentration, depended on the alkaloidal content of the species or variety of lupine used. The high nutritional value of lupine seeds has been attributed to their high crude protein content (BAINTNER 1967, CSUKÁS 1956, KELLNER—BECKER 1962, KRALOVÁNSZKY—TÖRÖK 1963). There are however, indications of the association of high alkaloidal content with a relative deficiency of sulphur-containing amino acids in lupine seeds (EVANS—BANDEMER 1967). Authors generally agree (CARR—PEARSON 1974, PETERSEN—DEANICKE 1974, WILKE 1974) that lupine should be used primarily in pig feeds, as a complementary rather than sole protein source (BAILEY *et al.* 1974). It has also been suggested that apart from the high crude protein content, consideration should be given to the possible presence of consumption-limiting anti-nutritive factors or even toxic factors. Opinions have been divergent, however, on the nature of the non-alkaloidal lupine components (minerals or biologically active compounds, such as tanning agents, haemolytic saponine, phenols, trypsin inhibitors) which could be held responsible for poisoning or a moderate feed refusal. The observations of other authors suggest that all these components share the responsibility for possible toxicity or feed refusal.

To obtain more information on the problem, a comparative analysis was performed in 1979 on five lupine varieties for biologically active and mineral components, and each species was tested in rat feeding experiments.

Materials and methods

Seeds of the following lupine species (varieties) were investigated:

1. *Lupinus albus* "Nyírség sweet" ("sweet I")
2. " " "revertant bitter"
3. " " "commercial bitter"
4. " " "white lupine sweet" ("sweet II")
5. *Lupinus luteus*, "HD-7"

All the seeds examined originate from the sandy soil of the experimental nursery in the Nyírség region; the soil has a slightly acidic character.

The chemical analysis of the seeds included a determination of the constituents and a quantitative determination of the minerals and main biologically active components [alkaloids, tanning agents, haemolytic saponine, trypsin inhibitor(s)], etc. (HARASZTI—VETTER 1980).

The crude protein was determined by Wagner—Parnas distillation after digestion with sulphuric acid. Crude fat was determined by the Soxhlet extraction method. Acid-detergent fibre (ADF-fibre), lignine, and cellulose contents were measured by the method of EDWARDS (1973). Crude ash was determined in the hydrochloric acid extract of ash, after 4-hour incineration of the sample at 550°C. Na, K, Sr, Cs and Ca were measured by flame photometry; P was measured by spectrophotometry, using the molybdo-vanadate complex proposed by SZALAY—FRENÝÓ (1962). Cl was determined by titration of the aqueous ash extract of the sample with AgNO_3 (SZALAY—FRENÝÓ 1962). For microelement determination, the sample was digested with a 5 : 1 nitrous acid — perchloric acid mixture, and aliquot parts of the digest were examined for Fe and Mg by spectrophotometry (TÖLGYESI 1969) and for Zn and Cu by polarography, after extraction with Na-diethyl-dithio-carbamate-chloroform (KOCH—KOCH 1974). Molybdenum was also determined by Koch and Koch's method, after incineration of the sample. The values were expressed in terms of %, g/kg or mg/kg, depending on the nature of the parameter.

The alkaloidal content was determined by ascendent paper chromatography (Schleicher—Schüll 2043b) of a 1% aqueous extract in butanol : acetic acid : water (4 : 1 : 5) solvent. The spots were detected with Dragendorff reagent (HAIS—MACEK 1961), and were evaluated for colour intensity by comparison to a spartein reference standard run parallel to the sample. The tanning agents were detected with the copper acetate technique proposed by SZALAY—FRENÝÓ (1962). Total haemolytic saponine content was determined by thin-layer (silica gel) chromatography (KOCH—PINTÁCSI 1969) of a 1% aqueous extract of the sample in i-propanol : formic acid : water (70 : 6 : 24). The haemolytic spots were detected with bovine blood containing gelatine, and their area was compared to that formed by the saponine reference standard (Merck). For the assay of trypsin inhibitor activity, casein was dissolved and hydrolysed in pH 7.35 acetate buffer at 37°C, precipitated with trichloroacetic acid and filtered; the filtrate was tested with the Folin reaction (LOWRY *et al.* 1951) for a comparison of substrate decomposition in the presence and absence of lupine seed extract.

Animal experiments

Experiment I. Coarsely ground seeds of the tested varieties were each added to a batch of commercial rat diet* (LATI) at 25% concentration, and after mixing, each experimental diet was pelleted. The feeding experiment lasted 36 days.

Experiment II. The alkaloids were extracted chemically from the ground seeds of each variety before addition to the rat diet at 25% concentration. The lupine-supplemented diets were pelleted and each was fed for 36 days as above.

Experiment III was carried out under the same conditions as experiment I, except that the non-extracted lupine seed rations added to the diet were ground to a fine, flour-like meal.

Six to ten 6-week-old male albino rats (LATI), 150—160 g in weight, were used in each group during the 63-day feeding experiment.

Inter-species differences between the lupine constituents were evaluated by variance analysis ($\text{LSD}_{5\%}$).

After the conclusion of the feeding trials all rats were exterminated. A detailed post mortem examination was performed and the liver and kidneys of 3 animals in each group were processed for histological examination. Excised pieces of the organs were fixed in formaldehyde and frozen, then the sections were dyed with hematoxiline-eosine. The lipids were evaluated with Oil-Red dye. For the EM examinations, the organs were fixed in glutaraldehyde and embedded in Durcupan.

Results

1. The constituents and mineral components of the examined lupine varieties, are shown in Tables 1 and 2, respectively. A detailed evaluation of these findings was reported earlier (HARASZTI—VETTER 1980); in the present paper only certain variety-specific features of nutritional relevance will be discussed. All the lupine varieties examined had a high crude protein content

* Composition: crude protein: 20.1%; crude fat: 5.0%; crude fibre: 4.2%; ash: 6.1%.

Table 1
Constituents of the lupine seeds

Species		Dry matter	Crude protein	Crude fat	ADF fibre	Lignine	Cellulose
		%					
1. <i>Lupinus albus</i>							
"sweet I"	\bar{x}	90.8	37.1	10.6	13.3	2.6	10.6
	s	0.4	0.3	0.06	0.41	0.3	0.69
2. <i>Lupinus albus</i>							
"revertant bitter"	\bar{x}	90.3	41.7	11.2	13.2	2.4	10.7
	s	0.2	0.1	0.49	0.18	0.16	0.38
3. <i>Lupinus albus</i>							
"commercial bitter"	\bar{x}	94.0	39.06	9.6	15.1	2.7	12.4
	s	0.3	0.37	0.45	0.8	0.16	0.7
4. <i>Lupinus albus</i>							
"sweet II"	\bar{x}	94.8	45.17	10.0	12.9	2.9	10.5
	s	0.6	0.93	0.08	0.18	0.24	0.68
5. <i>Lupinus luteus</i>							
"HD-7"	\bar{x}	93.4	46.29	6.4	17.8	1.9	15.9
	s	0.2	0.38	0.14	0.03	0.03	0.09

Table 2
Ash and mineral contents

		Ash	P	K	Na	Ca
		%	g/kg			
1. <i>Lupinus albus</i>						
"sweet I"	\bar{x}	3.6	4.6	13.6	0.33	0.77
	s	0.02	0.26	0.32	0.01	0.01
2. <i>Lupinus albus</i>						
"revertant bitter"	\bar{x}	3.7	4.4	14.2	0.33	0.88
	s	0.02	0.17	0.59	0.06	0.02
3. <i>Lupinus Albus</i>						
"commercial bitter"	\bar{x}	3.3	4.6	11.3	0.42	0.71
	s	0.02	0.13	0.6	0.01	0.03
4. <i>Lupinus albus</i>						
"sweet II"	\bar{x}	3.7	4.8	14.1	0.30	0.77
	s	0.01	0.2	0.19	0.02	0.01
5. <i>Lupinus luteus</i>						
"HD-7"	\bar{x}	4.9	8.4	17.3	0.39	0.70
	s	0.03	0.35	0.03	0.02	0.03

(range: 37–45%), but the crude fat constituent, as determined by Soxhlet extraction, varied widely (6.4–11.2%) between the varieties.

2. The ash content and certain minerals (Table 2) also differed considerably between the varieties. The *L. luteus* "HD-7" variety contained nearly twice as much phosphorus (8.4 g/kg) as the *L. albus* species (4.4–4.8 g/kg). Inter-species differences in potassium content showed a similar tendency, in that each *L. albus* species contained less K (11.3–14.1 g/kg) than *L. luteus* (17.3 g/kg).

As to microelements, unlike other authors, low iron content, but a markedly high manganese content was found in all the samples. The iron content varied between 32 and 52 mg/kg, while the manganese content was assessed as 950–1260 mg/kg in the *L. albus* varieties, and as 188 mg/kg in *L. luteus* "HD-7".

3. The utilization of the nutrients from lupine seeds may be adversely affected by toxic or inhibitor-like components, of which the alkaloids are the most important.

Paper chromatographic analysis for total alkaloidal content (Table 3 and Fig. 2), based on the quantitative determination of spartein, has shown that in contrast to the 0.2% level of alkaloids in the "sweet" *L. albus* varieties (Sample 1 and Sample 4), the "revertant bitter" (Sample 2) and "commercial bitter" (Sample 3) varieties contained as much as 2.2 and 3.2%, respectively.

in lupine seeds

Cl	Sr	Cs	Fe	Mn	Zn	Cu	Mo
mg/kg							
0.30	61.6	50.7	36.0	1131	15.2	11.3	0.9
0.02	1.8	1.1	3.16	52	1.34	1.5	0.02
0.32	66.8	54.7	37.7	957	19.5	7.4	0.5
0.007	3.5	0.8	3.67	46	2.0	1.7	0.009
0.25	54.7	51.7	32.1	1284	13.1	2.2	0.5
0.006	0.8	1.5	3.23	41.6	3.2	0.3	0.04
0.29	59.0	51.7	40.7	1259	28.4	1	0.6
0.023	3.8	1.5	3.84	32.7	4.4		0.02
0.31	63.1	52.2	52.1	188	25.9	8.1	0.4
0.006	0.3	0.3	5.1	18.3	3.5	1.6	0.01

Table 3

Alkaloid, saponine, tanning agent and trypsin inhibitor content of lupine seeds studied*

Species		Alkaloid content, %	No. of alkaloids detected	Saponine, mg/g	Tannic acid, %	Trypsin inhibitor activity %
1. <i>Lupinus albus</i> "sweet I"	\bar{x}	0.3	2	10.1	0.8	66
	s	0.013		0.9	0.14	
2. <i>Lupinus albus</i> "revertant bitter"	\bar{x}	2.2	4	12.2	1.0	48
	s	0.05		2.4	0.11	
3. <i>Lupinus albus</i> "commercial bitter"	\bar{x}	3.2	4	22.8	1.37	31
	s	0.02		4.5	0.27	
4. <i>Lupinus albus</i> "sweet II"	\bar{x}	0.2	2	9.9	1.17	51
	s	0.1		0.5	0.03	
5. <i>Lupinus luteus</i> "HD-7"	\bar{x}	traces	2	4.9	2.49	79
	s			0.9	0.21	

* In terms of trypsin activity of aqueous extracts.

However, only traces of spartein could be detected in the chromatogram of *L. luteus* "HD-7". Apart from spartein three other alkaloids were separated in the chromatograms at Rf values of 0.67, 0.61 and 0.48. Including spartein, four alkaloids were identified in the chromatograms of the "reverted bitter" and "commercial bitter" *L. albus* seeds, but only two (spartein plus the one at Rf 0.48) occurred in those of the other three species. The haemolytic saponine content (Table 3) was highest in the *L. albus* "commercial bitter" seeds, and lowest in *L. luteus* "HD-7". A direct correlation was demonstrable between the total alkaloid and saponine levels — if the one was high, the other was also high. No similar relationship was found between the quantity of tanning agents and trypsin inhibitor activity (Table 3).

4. The average weight gain of rats fed *L. albus* "commercial bitter" in Experiment I was only 52.3 g compared to 101 g in the control group. In the same experiment, rats fed *L. albus* "sweet I" also gained less than the controls (83.7 g). This is also obvious from the curves for weight gain (Fig. 3).

In Experiment II the extracted, alkaloid-free lupine supplements were examined for nutrition-physiological effects. The curves for weight gain are shown in Fig. 4. Comparison of the weight data showed that although the average gain was lowest in the group given *L. albus* "commercial bitter", the

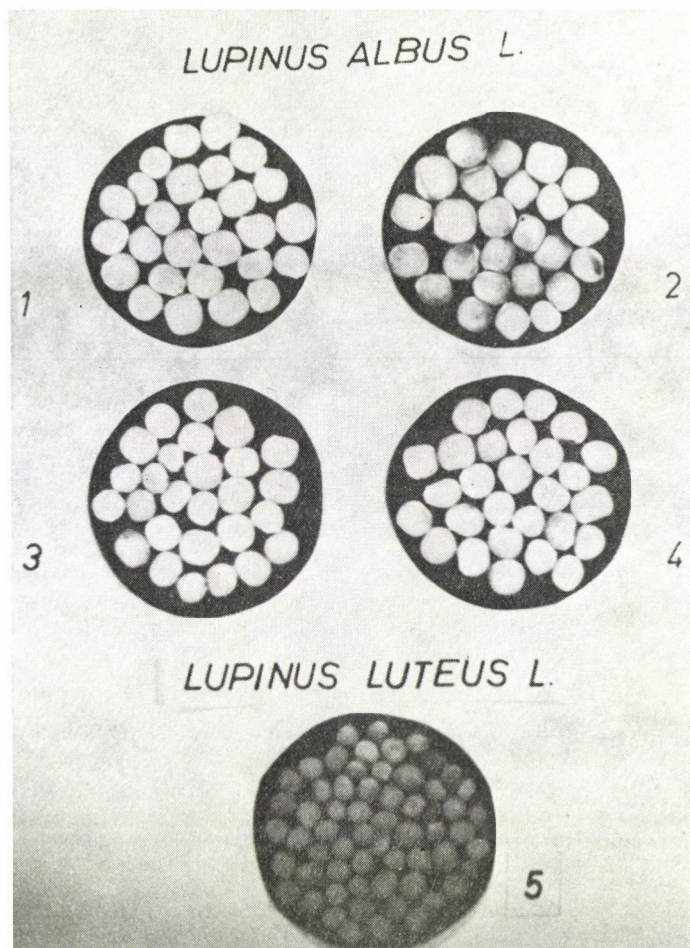


Fig. 1. Seeds of the five lupine varieties used in the feeding experiments

inter-group (inter-varieties) differences were not significant statistically. The greatest weight gain — practically identical with the control — was found in the group given *L. luteus* “HD-7”. This experiment also permitted the conclusion that the noxious effect of the alkaloid-rich “commercial bitter” species can be reduced by chemical extraction of the alkaloid.

The weight gains established in the comparative feeding trials performed under Experiment III (Table 4, Fig. 5) could be characterized by so-called saturation curves constructed on the general formula $y = A(1 - ab^x)$. The curve for the weight gain of the controls was very similar (with only 2–3% difference) to the weight curves for rats given *L. albus* “sweet I”, “sweet II”, “revertant bitter” and *L. luteus* “HD-7”. However, as the curve also shows,

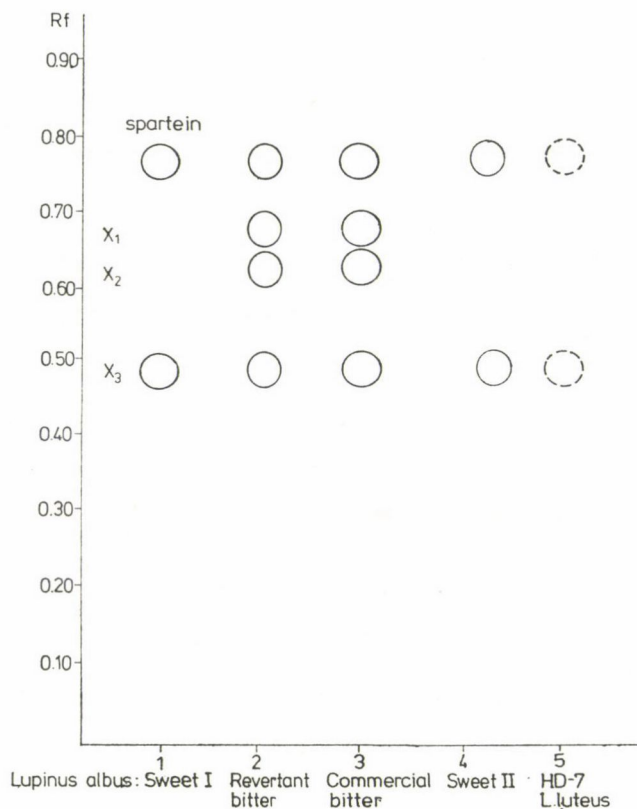


Fig. 2. Alkaloid components of the lupine species and varieties examined (as identified by paper chromatography)

rats given *L. albus* "commercial-bitter" gained significantly less weight (28.8% less) than the control and than rats given the other four lupine varieties.

The saturation curves show that only the *L. albus* "commercial bitter" variety was responsible for a notable depression of weight gain. Clinical symptoms, deaths or abnormal changes of behaviour did not occur in any group.

Addition of ground lupine seeds at 25% dietary level to the commercial rat diet (LATI), which was in itself of full biological value, accounted for a 22–25% increase in the crude protein content, but also for a similar (25–27%) decrease in crude fat content, and with the exception of one lupine species (*L. luteus* "HD-7"), a decrease in dietary phosphorus as well. The yeast, premix, casein, etc. contents of the experimental diet were also slightly decreased by lupine supplementation, but to the same degree by all lupine species, and were, therefore, obviously not responsible for inter-group (inter-species) variations in weight gain.

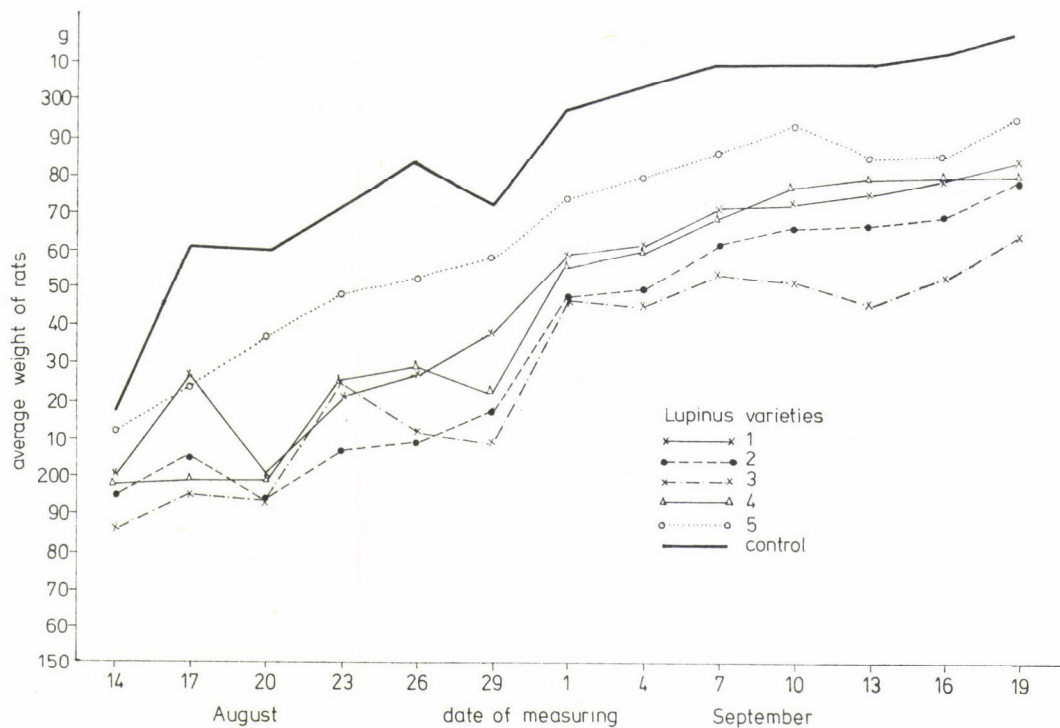


Fig. 3. Weight gain of rats in Experiment I (coarsely ground seeds fed for 36 days)

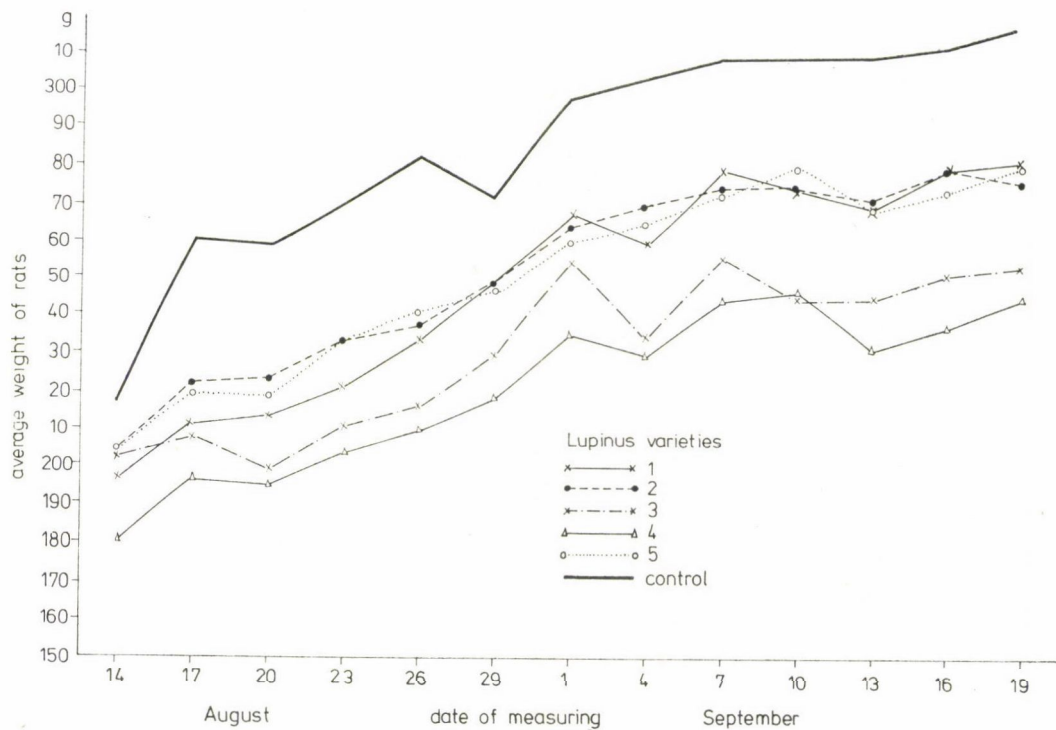


Fig. 4. Weight gain of rats in Experiment II (coarsely ground lupine seeds fed after chemical extraction of alkaloids for 36 days)

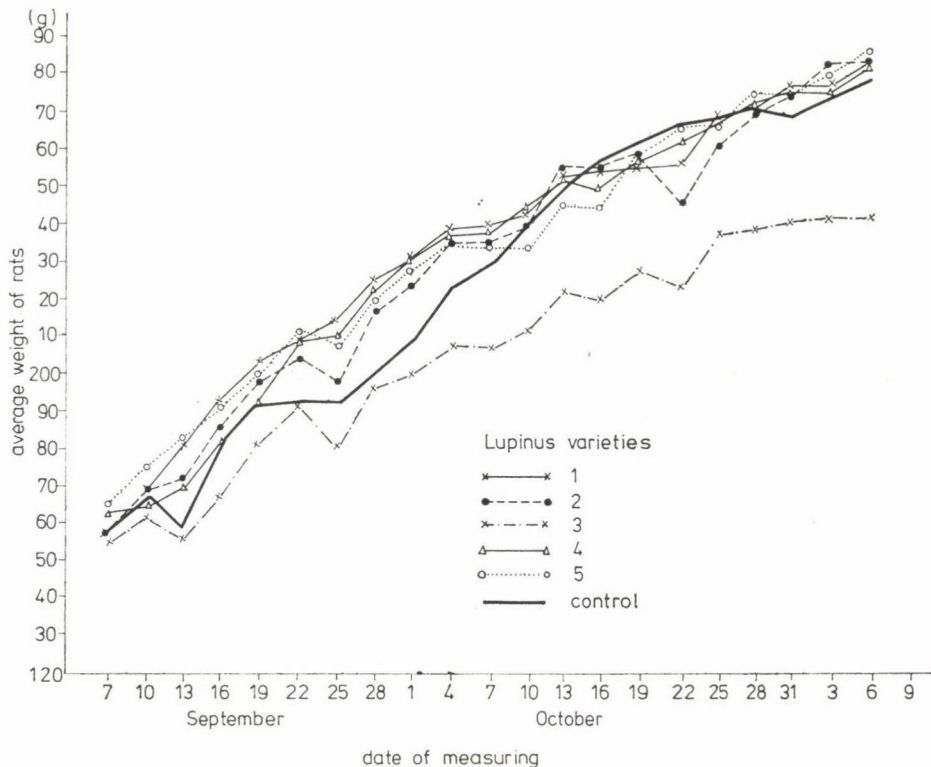


Fig. 5. Weight gain of rats in Experiment III (finely ground lupine seeds fed for 63 days)

5. Post-mortem and pathohistological examinations performed after the conclusion of the experiment revealed no gross or microscopic lesions attributable to the effect of lupine. No ultrastructural changes were detected either, by electron microscopic examination of the hepatocellular organelles in liver specimens secured on the day of extermination from two rats in each group.

It should be noted that a slight simple fat infiltration was demonstrated histologically in the liver of most experimental and control rats. As the control animals also showed the change, it was clearly unrelated to lupine, and in all probability was the consequence of the rich diet regime.

Conclusion

The experiments have shown that of the 5 lupine varieties examined, three (*L. albus* "sweet I", "sweet II" and *L. luteus* "HD-7") can be safely used, on the basis of rat (model) experiments, as the protein component of fodder diets for domestic animals at a 25% dietary concentration.

Table 4

Average body weight gains in rat groups during experimental feeding with diets containing lupine seeds

Species		Experiment I Coarsely ground seeds Feeding period: 36 days	Experiment II Extracted (alkaloid-free) Feeding period: 36 days	Experiment III Finely ground lupine seed meal Feeding period: 63 days
1. <i>Lupinus albus</i> "sweet I"	\bar{x}	83.7	84.8	127.8
	s	32.5	17.1	26.2
	CV	38.8	20.0	8.3
	%	82.9	83.1	104.6
2. <i>Lupinus albus</i> "revertant bitter"	\bar{x}	72.0	82.0	127.2
	s	17.9	36.9	26.8
	CV	24.8	45.0	21.0
	%	71.3	38.8	104.1
3. <i>Lupinus albus</i> "commercial bitter"	\bar{x}	52.3	76.9	87.0
	s	21.4	13.9	19.3
	CV	40.9	18.1	22.1
	%	51.8	76.2	71.2
4. <i>Lupinus albus</i> "sweet II"	\bar{x}	63.8	81.0	118.2
	s	17.8	29.1	41.8
	CV	27.9	35.9	35.4
	%	63.2	80.2	96.7
5. <i>Lupinus luteus</i> "HD-7"	\bar{x}	75.0	97.0	120.0
	s	30.4	19.6	29.2
	CV	40.5	20.2	24.2
	%	31.8	96.0	98.2
Control	\bar{x}	101		122.1
	s	28.4		17.8
	CV	28.1		14.5
	%	100		100

\bar{x} — arithmetic mean (g); s — standard deviation; CV — variation coefficient; % — standard error of the mean (as %).

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VARIA I

CHANGES IN THE NUTRIENT CONTENT OF GRASS IN RESPONSE TO CERTAIN SOIL PROPERTIES

Fifteen per cent of the agriculturally utilizable area of Hungary is occupied by grasslands. The maximum exploitation of the possibilities offered by this vast area is of national interest. The aim is to achieve up-to-date grass management, by raising yield averages and increasing the nutrient contents of the crops. Increasing yields is primarily a task for production technology. Among other things the nutritive value of the crop can be influenced by the cultural methods employed. Increased crude protein content in grasses as a result of nitrogen fertilization is reported by ECKER (1979). A slight accumulation of minerals in meadow hay as a response to nitrogen nutrition was observed by HARASZTI (1966) and TÖLGYESI—HARASZTI (1967). The phenophase (RÉGIUS-MŐCSÉNYI—VÁRHEGYI 1978) and the manner of utilization (HARSÁNYI 1977) also have considerable influence on the nutrient content. However, the changes induced by agrotechnical means in the nutrient content can, in fact, be traced back to interactions between the plant and the nutritive medium, or the plant and the growing site. Differences in nutrient uptake between plants are mostly of genetic origin and characteristic of species or family. But changes in the site conditions may result in 30-40% differences even within the same species (TÖLGYESI 1969), and in extreme cases these factors may even determine whether a given crop can be successfully cultivated or not.

The effects of soil type, pH and nutrient content on the nutritive elements of grasslands with a mixed botanical composition are known (TÖLGYESI *et al.* 1968, 1970, TÖLGYESI—CSAPODI 1973, TÖLGYESI—KÁRPÁTI 1977, SZALAY *et al.* 1970a, b, SÁMSONI *et al.* 1971, 1975). A study on other factors in a relatively small production area may, however, command interest. In the present paper an account will, therefore, be given of how certain soil properties modify the nutrient content on the most typical growing sites in Bács-Kiskun county.

To study the question samples were collected from the first growth in 1978 from grasslands of mixed botanical composition at 14 state farms in the county. The samples were taken between 1st and 10th May, so effects caused by phenophase differences, which might have modified the findings, could not prevail (RÉGIUS-MŐCSÉNYI—VÁRHEGYI 1978).

Parallel to the plant samples, soil samples were taken from the 0-20 cm layer to study various soil properties. The soil and plant samples were taken from the following soil types: chernozem, deep salty meadow chernozem, meadow solonetz, drift sand, sandy meadow and marshy meadow soils. The 156 plant samples thus collected were dried at temperatures of 60-80°C, then ground. The analyses were made on ground, air-dried material. Stock solutions for the examination of the individual elements were prepared by reducing the material to ashes at 500°C. Potassium, sodium and calcium were determined with a flame photometer, while a Unicam SP 90 A type atom absorption spectrophotometer was used for the determination of magnesium, iron, manganese and zinc. Phosphorus, copper and molybdenum were evaluated by colorimetry. Nitrogen was determined with Kjeldahl's destruction method, while the other qualitative characters of fodder crops were determined according to the MNOSZ standard No. 6830-53. The soil analyses were carried out on the basis of the book: *Methods for Soil and Manure Analysis*.

Table 1
Nutrient contents

Sampling site	N	P	K	Ca	Na	Mg
	g/kg					
<i>Városföld</i>						
Centre	28.3	3.22	21.23	4.67	1.20	2.98
Petőfiszállás	24.6	2.41	15.44	4.70	0.78	3.77
Bugac	26.7	2.80	21.58	5.27	1.13	2.74
Kiskunfélegyháza	20.7	2.10	17.75	3.34	4.41	2.11
<i>Kiskőrös</i>						
Kovács farm	22.4	1.80	20.12	5.63	0.90	3.52
Ökördi	26.3	1.82	18.45	5.61	0.79	3.35
Soltvadkert	26.5	1.37	11.05	6.74	1.23	4.63
<i>Izsák</i>	30.3	3.05	25.13	4.11	1.07	4.38
<i>Helvécia-Ágasegyháza</i>	23.2	2.14	17.08	7.24	1.05	4.33
<i>Kiskunhalas</i>						
Centre	24.0	2.60	20.15	3.86	0.92	3.23
Rekettye	20.0	2.34	17.50	5.08	0.46	1.93
Kunfehértó	22.7	2.49	19.35	4.01	1.09	3.42
Tajó	22.7	2.88	21.20	2.82	1.28	2.60
Balotaszállás	23.2	2.76	21.85	3.36	0.89	3.34

Soil analyses at the different sampling sites supplied the following extreme values: Arany's viscosity index: 25—45, CaCO_3 %: 6.9—28, pH (KCl): 7—7.9, humus %: 1.3—3.7, ammonium lactate-soluble P_2O_5 mg/100 g soil: 14—44, K_2O mg/100 g soil: 10—33. The data give evidence of growing sites with differing colloid, humus and lime contents and pH values. When the plant analysis data are considered from the point of view of feeding value it can be seen that while the fodder crops contain nitrogen, potassium and sodium in satisfactory quantities, they are deficient in phosphorus and calcium, and over-supplied with magnesium. The samples from most growing sites reached the specified 100—160 mg/kg level of iron and some of them even exceeded it. As regards manganese zinc and copper, on the other hand, all the samples were deficient, except for the zinc and copper contents at Soltvadkert. The molybdenum levels of the grasses were satisfactory. While the data on fibre and starch show acceptable values, the digestible protein contents of all but the Izsák samples are low.

To study the influence of various soil properties on the nutrient content of the plants the soil samples were placed in groups with increasing clay content on the basis of Arany's viscosity index. The mean humus and lime contents of the samples in the individual groups are also given in the heading of Table 2, which demonstrates that fine-structured soils have higher humus contents than coarse-grained soils (TISDALE—NELSON 1966), and at the same time shows the accumulation of calcium carbonate in the fractions, as already observed in

of grasses

Fe	Mn	Zn	Cu	Mo	Dry matter, g/kg	Raw fibre	Dig. protein	Starch equival.
mg/kg						g/kg dry matter		
285	34.50	22.60	7.2	0.76	260.6	252.1	114.3	533.5
215	35.13	23.56	5.5	0.85	302.0	235.7	106.1	529.7
163	35.50	32.30	6.7	0.91	245.4	240.0	118.8	559.5
124	43.93	22.07	4.7	0.79	290.1	270.2	86.4	512.0
221	29.09	23.61	5.4	1.47	263.0	237.3	94.5	535.4
378	48.00	29.80	5.8	1.36	303.3	244.3	111.1	505.7
460	49.00	34.70	8.1	1.34	321.0	240.0	112.6	521.3
264	24.23	28.30	6.6	1.05	210.5	233.0	130.0	554.0
217	31.30	24.50	5.2	1.21	291.5	236.3	98.8	550.8
151	24.00	23.60	3.3	1.30	251.7	265.2	99.7	511.0
89	25.00	26.50	4.5	1.24	288.6	268.8	83.3	515.0
135	30.20	23.60	4.7	1.03	256.5	274.8	95.4	512.0
152	34.50	21.40	3.5	1.34	267.1	259.8	95.3	521.3
127	29.82	25.18	4.4	1.31	271.4	270.6	97.0	511.0

earlier investigations (PROHÁSZKA 1978). The data on nutritive elements in the table are the averages of the components of plants belonging to the same group.

The results of the analyses reveal that the nitrogen content of the grass increases as a function of the humus level of the soil. Although the humus level is the highest of all in marshy soils, the C/N ratio in this case is high, the nitrogen supplying capacity is poor, and the nitrogen content of the vegetation is consequently low. The phosphorus and potassium values of the plants show maxima in loamy soils with moderate humus and lime contents, although the phosphorus and potassium supplies of the soils increase as clay accumulates (SCHEFFER *et al.* 1960, STEFANOVITS 1975). In the group with higher clay, humus and lime contents the lower values of phosphorus and potassium are due to the absorption of these elements in alkali media under the influence of a high clay content (TISDALE—NELSON 1966, STEFANOVITS 1975). The soil properties in question did not affect the calcium content of the grasses. The low biological calcium requirement of grasses seems to be satisfied by the soils. The increasing values of magnesium and sodium in the plants can be explained by a similar change in the clay content of the soil. The lower supplies of these elements in marshy soils can be attributed partly to the higher moisture content of the soil.

The values of iron, manganese, zinc and copper in the grasses showed tendencies similar to those of phosphorus and potassium. In groups with higher lime, humus and clay contents they decreased in quantity owing to the absorption caused by the soil characteristics.

Table 2
Nutrient content of grass as a function of soil properties

Arany's viscosity index	<30	30—37	37—42	42—50	50—60	>60
Humus, %	0.70	1.95	2.73	3.39	4.22	4.70
CaCO ₃ , %	5.24	10.50	13.40	23.00	29.80	31.10
N, g/kg	22.00	22.80	24.50	24.50	25.00	21.70
P, g/kg	2.28	3.33	2.81	2.28	2.42	2.19
K, g/kg	17.20	20.60	21.20	20.30	18.00	18.30
Ca, g/kg	4.20	3.90	4.00	4.60	4.50	4.60
Na, g/kg	0.78	1.09	1.47	1.71	1.51	0.98
Mg, g/kg	2.25	3.05	2.74	3.20	4.01	3.85
Fe, mg/kg	168.00	181.00	178.00	171.00	171.00	225.00
Mn, mg/kg	35.50	30.80	38.30	33.50	33.10	26.10
Zn, mg/kg	23.80	27.00	27.30	26.50	25.20	26.20
Cu, mg/kg	5.00	5.72	5.74	5.31	5.36	4.78
Mo, mg/kg	1.14	1.11	0.95	1.02	1.08	1.16
Dry matter, g/kg	270.00	262.00	255.00	263.00	247.00	264.00
Raw fibre, g/kg	251.00	257.00	257.00	252.00	245.00	256.00

The reduction in manganese, zinc and copper as a reaction to lime, humus and clay in the soil was observed in earlier experiments carried out with young wheat plants (PROHÁSZKA 1978). The molybdenum levels in the plants hardly changed. This proves the dominant role of high pH values in the molybdenum uptake of plants. Due to the reducing conditions which prevail in marshy soils, iron becomes readily available, thus explaining the high iron contents of the plants. The lower values of manganese, zinc and copper on marshy soils can be explained by the high retention capacity of humic acids (SZALAY *et al.* 1970a, b, 1977, SÁMSONI *et al.* 1971, 1975). Changes in the dry matter contents of the grasses are associated with the high water retention of clay and humus. The relatively stable fibre values are due to the fact that the samples were taken at the same stage of development.

Besides the effects of the soil properties examined, changes in the values of the components can be associated with interactions between individual elements. Thus, in Table 1, the nitrogen values of the grasses show a correlation with the copper values. The correlation is characterized by the following parameters: $P = 1\%$, $r = 0.72$, $n = 14$; $P = 0.1\%$, $r = 0.56$, $N = 156$. A similar correlation has been found in other cases as well (TÖLCYESI—DEBRECENI 1974, PROHÁSZKA—GURABI 1974). The connection between nitrogen and magnesium arises from the structure of the chlorophyll molecule. Parameters expressing the correlation are: $P = 5\%$, $r = 0.50$, $n = 14$. A correlation was also found between the concentrations of potassium and calcium in the plants, as expressed by the following parameters: $P = 5\%$, $r = -0.54$, $n = 14$. These interactions are well known from the literature (BERGMANN—NEUBERT 1976). Interactions exist not only between individual elements, but also in connection with the nutritive elements and the qualitative traits of the fodder crops.

Nitrogen is in negative correlation with the dry matter and raw fibre contents of the plants. The correlations can be expressed by the following data: $P = 0.1\%$, $r = -0.58$,

$n = 156$; and $P = 0.1\%$, $r = -0.60$, $n = 156$, respectively. A close positive correlation can be observed between nitrogen and digestible protein. The parameters expressing the correlation are: $P = 0.1\%$, $r = 0.90$, $n = 156$. Digestible protein is in negative correlation with the raw fibre content, and in positive correlation with the copper content. The parameters of these correlations are: $P = 0.1\%$, $r = -0.61$, $n = 156$; and $P = 0.1\%$, $r = 0.66$, $n = 156$, respectively. The correlation between the raw fibre contents and starch equivalents of the grasses was also negative, as characterized by the following data: $P = 0.1\%$, $r = -0.72$, $n = 156$.

The results of the investigations prove that the component values of the plants depend on numerous factors even within a small growing area. A knowledge of these factors is important for farmers. Although a knowledge of the type, viscosity, humus and lime content of the soil cannot replace a laboratory analysis of the fodder crops, when laboratory analyses are not available this knowledge is nevertheless of assistance in judging the relative nutrient content of the fodder crop.

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REGULATION OF THE DEVELOPMENT OF WINTER WHEAT VARIETIES USING SHORT DAY ILLUMINATION AND LOW TEMPERATURE

The regulation of wheat development is indispensable if varieties with short and long vegetation periods are to be crossed under artificial conditions. To this end the effect of illumination period and temperature on the heading date has already been examined (BALLA 1982, 1982). In the present paper the combined effect of short day illumination and low temperature on wheat development is studied.

The investigations were conducted in the phytotron at the Agricultural Research Institute of the Hungarian Academy of Sciences, Martonvásár. In this programme short day (10 hours) illumination and three temperature variants were used to regulate (retard) development. These were as follows:

- control, i.e. normal temperature (varying from 16/15° to 20/15°C day/night from planting to heading) and normal illumination (gradually increasing from 13 hours 10 minutes to 16 hours),
- short day illumination (10 hours), (R),
- short day illumination (10 hours) + temperature 6°C lower than the normal programme (R-6),
- short day illumination (10 hours) + temperature 9°C lower than the normal programme (R-9).

The illumination was provided by Gro-Lux/WS and Cool White fluorescent tubes, with an intensity of 20—25 thousand lux ($400 \mu\text{E}/\text{m}^2/\text{sec}$).

Three varieties of different origin and with different vegetation periods were chosen for the investigations.

Sadovo 1: an early, winter hardy variety of southern origin. Pedigree: Jubileinaya III \times Bezostaya 1. Bred at Sadovo, Bulgaria.

Bezostaya 1: a midseason, winter hardy variety, introduced into Hungary. Pedigree: Lutescens 17 \times Skorospelka 2. Bred at Krasnodar, Soviet Union.

Maris Huntsman: a late, winter hardy variety of northern origin. Pedigree: (CI 12633 \times Capelle D.₅) \times Hyb 46 \times (Capelle D. \times Prof. Marchal₂). Bred at Cambridge, England.

The seeds of the varieties were germinated in Petri dishes, then planted in plastic tubes and vernalised in the seedling state for 45 days in a chamber at 2°C under weak blue illumination. The plants were then transferred to pots and placed in a phytotron chamber (GB), where they were raised on the normal programme devised by S. and E. Rajki (for details, see BALLA 1980). The treatments were carried out on the basis of the Feekes scale of development. When plants raised on the normal programme reached the appropriate phase of development, they were transferred to another chamber (E 15 VH), with short illumination and low temperature, as required for the treatment. The plants were kept there until they had completed the relevant phase of development.

The treatments can be divided into three groups:

1. Treatment over two developmental phases (1—2, 3—4, 5—6, 7—8 or 9—10.1)
2. Treatment over four or six developmental phases (1—4, 5—8 or 5—10)
3. Treatment from planting to heading (1—10.1)
4. Control, raised on the normal programme.

Each treatment consisted of 10 plants with three replications. The effect of low temperature and short day illumination on the course of development was determined by observing the heading date (days from planting to heading). The plants were kept under observation for 93 days, after which the examination was terminated.

As a result of twice daily watering and a regular supply of nutrients two or three normally sized ears were obtained on average on each plant.

The effect of treatments applied during various phases of development on the heading date can be seen in Table 1.

Table 1
Effect of low temperature and short day illumination applied in various phases of development on heading in wheat

Treatment in phases	Effect of 1 °C change in temperature under short day (days)		
	Sadovo 1	Bezostaya 1	Maris Huntsman
1—2	0.69	0.67	0.52
3—4	0.76	0.33	0.76
5—6	1.33	0.55	1.57
7—8	1.24	0.69	1.79
9—10.1	1.17	0.74	1.45
1—4	2.05	1.81	2.38
5—8	2.74	3.88	1.69

Under normal illumination at the temperature used in the normal programme, Sadovo 1 headed on the 51st day after planting. If it was raised on short day in developmental phases 1—2 or 5—6 its development slowed down and heading was 4 or 7 days later, respectively, than in the control. Treatment in phases 3—4, 7—8 or 9—10.1 proved ineffective. The retardation in development was greater if the treatment was carried out in phases 1—4 or 5—8, and was most pronounced if the plants were raised under short day illumination from planting to heading.

The development-retarding effect of short day (10 hours) illumination and a temperature 6°C lower than the normal programme was expressed in all developmental phases, but it was only significant if the treatment was carried out in phases 5—6, 9—10.1, 1—4 or 5—8. Under the effect of these treatments Sadovo 1 headed 11—21 days later than the control. Naturally, it headed latest if the plants were raised under short day illumination at 6°C below the normal temperature from planting to heading (1—10.1).

The combined effect of short day illumination and a temperature 9°C lower than normal was even stronger. This treatment caused severe delays in the heading of Sadovo 1 in all phases. Treatment during the pre-heading phases (9—10.1 or 5—8) was particularly effective.

The response of Bezostaya 1 to treatments applied in various developmental phases was similar to that of Sadovo 1. The 5—6 day difference in heading date between the two varieties on the normal programme remained unchanged in the majority of treatments, showing the similarity of the response. However, treatment in phases 5—8 retarded the development of Bezostaya 1 more than that of Sadovo 1. Bezostaya 1 headed latest when treatment was continued throughout developmental phases 1—10.1.

Maris Huntsman, which is of northern origin and has a long vegetation period, headed 64 days after heading on the normal programme. This variety only responded to short day illumination if the treatment was carried out in developmental phases 5—6, 7—8 or 5—8. However, development was significantly retarded if short day was associated with low temperature. The effect was greater if the treatment occurred in the later stages of vegetative growth, though a temperature 9°C lower than the normal programme caused a significant retardation in any phase of development. Treatment in phases 5—8 or 1—10.1 doubled the number of days from planting to heading compared to the normal control.

Since Maris Huntsman is a late variety under Hungarian conditions there is unlikely to be any necessity for retarding its development. What is more important is how the variant grown under normal illumination can be made to flower simultaneously with early or mid-season varieties. The data in Table 1 show that there are several treatment variants for Sadovo 1 and Bezostaya 1 which will flower at the same time as Maris Huntsman if the latter is raised on the normal programme.

Since treatments over four developmental phases are very effective, these are analysed in Figs 1 and 2.

The effect of treatment in developmental phases 1—4 is linear for all three varieties (Fig. 1). The r values show a close correlation. If an imaginary line is drawn parallel to the horizontal axis, the points of intersection between this line and the regression lines of the three varieties show the necessary treatments on the horizontal axis and the mutual flowering date on the vertical axis. For example, Maris Huntsman raised under short day illumination, Bezostaya 1 raised under short day illumination at 4°C below the normal temperature and Sadovo 1 raised under short day illumination at a temperature 7°C lower than normal will all head on the 70th day after planting.

From Fig. 2 it can be seen that when short day illumination and low temperature are applied in developmental phases 5—8 it is impossible to draw an imaginary line parallel to the horizontal axis which will intersect the regression lines of all three varieties. In other

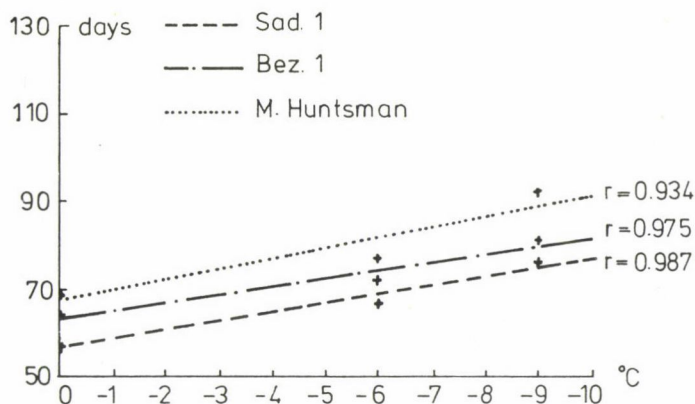


Fig. 1. Effect of short day + low temperature applied in development phases 1-4 on heading date

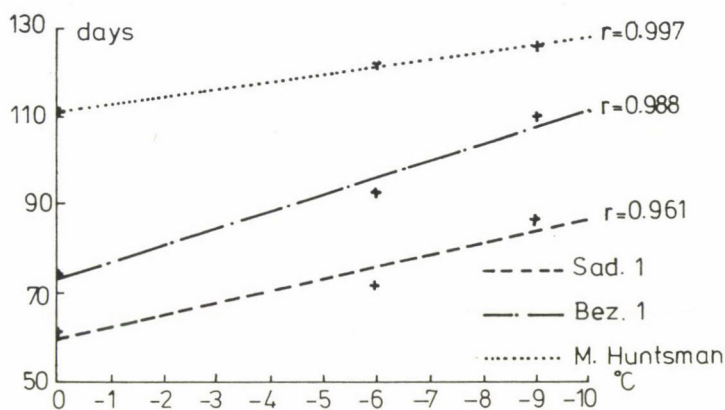


Fig. 2. Effect of short day + low temperature applied in development phases 5-8 on heading date

words, in these treatments it is impossible to achieve nicking in the flowering times. However, if Maris Huntsman is raised on the normal programme, when it heads after 64 days, or if this variety is treated in developmental phases 1-4, several treatment variants are possible.

The steepness of the regression lines in Fig. 2 gives a clear indication that Bezostaya 1 is more sensitive to a change in temperature in phases 5-8 than the other two varieties tested.

The data can also be used to determine the sensitivity of wheat to various treatments in different phases of development. The results are presented in Table 2. The data in the table confirm that treatment is most effective in developmental phases 1-4 or 5-8. In developmental phases 5-8 a 1°C reduction in temperature under short day conditions delayed heading in Sadovo 1 by 2.74 days, in Bezostaya 1 by 3.88 days and in Maris Huntsman by 1.69 days. A knowledge of these data allows the breeder to regulate the vegetation period of these wheat varieties at will, and to achieve nicking in the flowering times of early and late varieties.

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FLOWERING IN APRICOT VARIETIES

As a result of 20 years of observations on flowering phenology certain flowering characteristics and the time of flowering have been established for the apricot varieties currently grown in Hungary. The varieties were placed in three groups (early, medium and late) according to the time of flowering. Most of the commercially produced varieties flower early or in midseason. It has been found that the variety, the variant within the variety, the crop year, the root-stock and the growing site may in extreme cases put the commencement of flowering forward or back by 5, 6, 20, 3 or 6 days, respectively, compared to the usual date. Some of the varieties (Magyar kajszai C.235/2, Magyar kajszai C.256, Kései rózsza C.1792, Rakovszky kajszai C.333 and Hetényi rózsza C.777) have stable flowering times, while others (Ceglédi óriás, Ceglédi hajnalpír, Magyar kajszai C.235 and Kecskeméti rózsza C.778) are unstable.

The period for which the generative organs function is determined by the joint effect of variety, crop year and growing site. The duration of pollen distribution ranged from 0.5 to 2 days, and that of the secretory activity of the stigma from 1 to 4.5 days.

Investigations on the flowering time of apricot varieties have revealed that owing to frequent late spring frosts the present range of varieties is unable to ensure reliable apricot production in Hungary. Attention should be paid to breeding and introducing late flowering varieties and to clarifying the biological nature of frost resistance in the present varieties; furthermore, optimum growing sites must be chosen and suitable root-stocks, and mechanical and chemical methods of delaying the flowering date must be used.

Hungary is one of the most northerly points where apricots can be grown, so this increases the difficulties encountered in trying to extend the production area of apricots using the present variety collection.

The greatest problem is represented by the low, fluctuating yields, which are due partly to the relatively short dormancy period and early flowering time of the species and varieties, and partly to the following circumstances: 1. in earlier years orchards were often established for economic considerations, not always at sites with favourable climatic and soil conditions; 2. owing to the generally accepted view that apricots have no particular requirements, the

level of nutrient replacement and cultivation was low; 3. deficiently selfing varieties were not always combined with the right varieties in the orchards.

Of these factors, the flowering times of species and varieties and the evaluation of factors influencing these times were chosen as the objects of investigation, and an answer was sought to the questions; a) what factors determine the time of flowering, b) to what extent do they influence the initiation, course and duration of flowering, and c) can the phenological characteristics of the generative organs be determined, and what relation is there between these characteristics and fertilization.

The flowering time of apricot varieties has been studied by many authors both in Hungary and abroad. Apricots flower early compared to other fruit species (BRÓZIK 1975), and different varieties also blossom at different times. The flowering time of the varieties is determined and influenced by the air temperature conditions after the dormant period, which can be characterized by the total heat units.

A correlation between the heat units and the date of flowering has been demonstrated by a number of authors, the only difference being in the method of calculation, SAFIR —

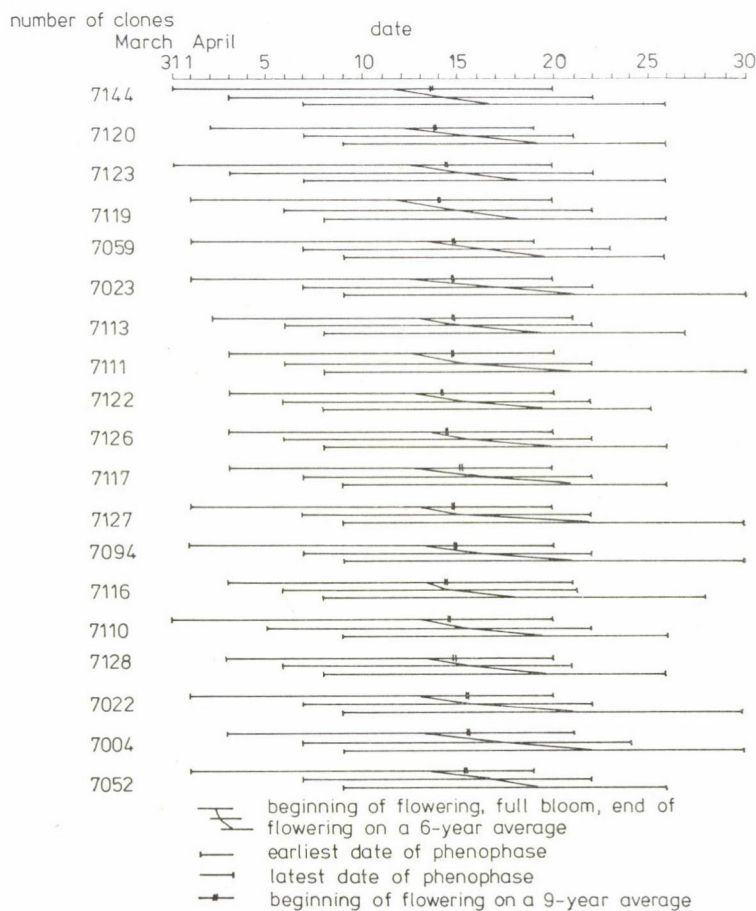


Fig. 1. Flowering time in Magyar kajszi apricot clones (1959—1961, 1962—1966, 1977—1978, Cegléd)

BESPECHALNAYA (1970), MOLNÁR—TURI (1974), SMYKOV (1978) and BRÓZIK Jr. et al. (1978) totalled the daily mean temperatures above 0°C from 1st January; VITANOV (1963) totalled the daily temperature means above 0°C from 1st February and NYUJTÓ—TOMCSÁNYI (1959) totalled the daily mean temperatures above $+5^{\circ}\text{C}$ $+6^{\circ}\text{C}$ for the month preceding the flowering period, while SAFIR—BESPECHALNAYA (1970) totalled the daily temperature maxima above $+5^{\circ}\text{C}$ in the month before flowering and took this as the basis of calculation.

When studying factors influencing the time of flowering, DUHAN (1944), LÖSCHNIG—PASSECKER (1954), MALIGA (1966), BRÓZIK—NYÉKI (1975), BLASSE (1976) and NYUJTÓ (1978) pointed out differences in flowering time between the varieties, while the relative order of flowering at a given growing site remained more or less the same in successive years. Accordingly, these authors placed the varieties in three flowering groups, namely early, medium and late.

Setting up flowering time groups makes it possible to plant varieties belonging to the same group together, which is of particular importance in the case of self-sterile and partially self-fertile varieties. The greater the overlap between the flowering periods, the better the conditions of pollination are (BRÓZIK—NYÉKI 1975).

Apart from varietal traits, the date when flowering begins may be influenced by the crop year (± 10 days: KUZNETSOV 1972, BRÓZIK 1975, NYUJTÓ 1978, BRÓZIK Jr. et al. 1978), the growing site (± 10 days: MARIČIĆ 1968), the root-stock (± 2 days: NYUJTÓ 1978), pruning (NIKOLOV 1974), the age of the bearing part (± 2 days: NYUJTÓ 1978, KECSKEMÉTI 1979 unpublished), the nutrient content of the soil and the number of sunshine hours (DUHAN 1944), late spring frosts (RYADNOVA 1960) and irrigation against frost (STANG et al. 1977).

The date of flowering is in very close correlation with other morphological and phenological properties too. The authors found the time of flowering to be related with the number of

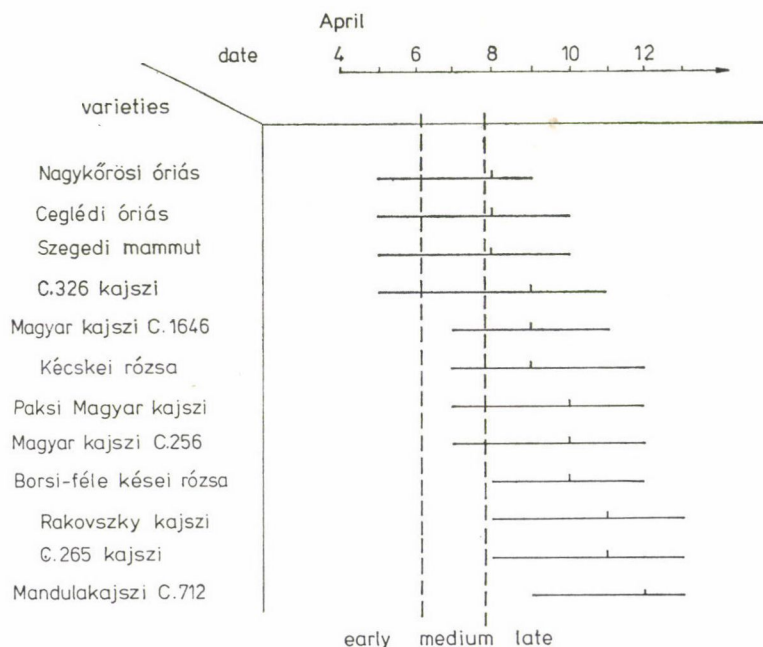


Fig. 2. Relative order of flowering in apricot varieties (1978, Cegléd)

anthers (VACHUN 1973), the time of fruit ripening (BAKER—BROOKS 1944, MALIGA 1960, MOLNÁR 1974) and the time of flower differentiation (BROWN 1953).

The length of time for which the generative organs are able to function was studied by BRÓZIK JR. *et al.* (1978) who found differences between varieties and crop years in the functional coincidence of anthers and pistil; homogamy is infrequent in the flowers (female precedence) and cleistogamy also occurs.

The investigations were carried out on the variety collections of the Research Institute for Fruit-trees and Ornamentals (formerly Horticultural Research Institute) at Érd-Elvira between 1958 and 1970 and at Cegléd from 1958 to 1978.

The experimental material consisted of some 500 varieties and forms collected from several growing sites in Hungary. The varieties and clones were grafted to seedling stocks and trained into trees with medium high trunks and combined crowns. They were then planted in micro-plots of 5—10 trees spaced at 7×6 or 8×8 m between 1955 and 1972.

The observations included 1. the flowering phenology of the varieties examined, i.e. the dates of beginning of flowering, full bloom and end of flowering (when 5—10 and 50—75% of the flowers had opened, and 5% had shed their petals, respectively), 2. factors influencing the time of flowering, namely the effects of growing site (Érd-Elvira, Cegléd), crop year and root-stock (C.359, C.1431 myrobalan; C.580, C.1652, C.2703 Pr. armeniaca; C.2630 peach; C.410 Pr. amygdalo-persica), 3. the functions of the generative organs in 20 numbered flowers per variety, to establish the beginning and completion of anther dehiscence, and the "dull", "shiny" and "brown" stages of the stigma, twice a day, at 9 a.m. and 3 p.m.

The data were totalled, then the phenological stages were characterized as average and percentage values.

The results of studies aimed at determining the flowering times of apricot varieties showed that the characteristics of some varieties differed from one clone to another in the course of cultivation. NYUJTÓ—TOMCSÁNYI (1959) and BRÓZIK (1960) no longer speak of varieties, but of varietal groups which have come into existence in Hungary for the two

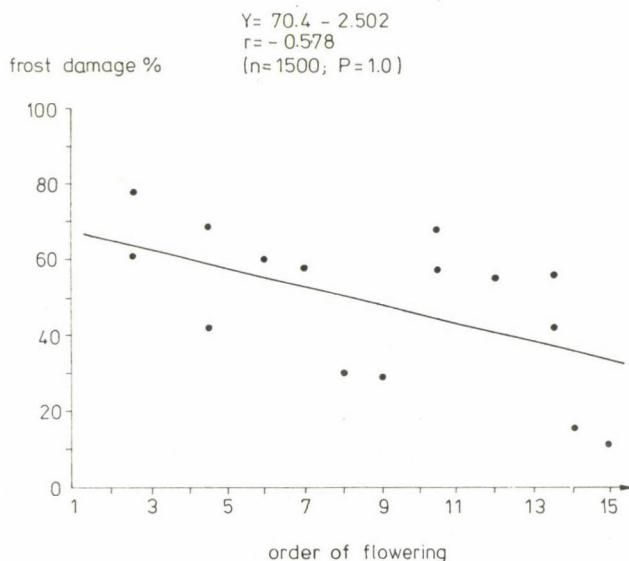


Fig. 3. Relationship between flowering time and frost damage to flowers in apricot varieties (1978, Cegléd)

Table 1
Effects of growing site and crop year on

Year	Growing site	Number of clones	Date of the beginning of flowering	Number of days from the beginning			
				1	2	3	4
<i>Beginning of flowering</i>							
1964	Cegléd	110	13th April	1%	1%	4%	78%
	Érd	37	16th April	3%	43%	51%	3%
1965	Cegléd	113	7th April	2%	54%	23%	11%
	Érd	52	10th April	6%	58%	36%	
1966	Cegléd	113	25th March	2%	0%	2%	5%
	Érd	52	1st April	4%	7%	38%	11%

Full bloom

1964	Cegléd	109	16th April	1%	3%	50%	33%
	Érd	35	17th April	3%	40%	49%	8%
1965	Cegléd	114	9th April	1%	5%	0%	2%
	Érd	52	12th April	2%	0%	50%	4%
1966	Cegléd	114	2nd April	4%	1%	0%	0%
	Érd	53	6th April	11%	13%	16%	27%

longest cultivated varieties, namely, the Magyar kajszi and Rózsabarack groups of varieties. Fig. 1 shows the 6-year and 9-year flowering phenograms for 19 Magyar kajszi clones.

There was nearly 2 days' difference between the clones in the average date of the beginning of flowering, while the difference in the dates of full bloom and the end of flowering was more than 4 days.

In the course of the years covered by the study the date of the beginning of flowering shifted by a maximum of 21 days, that of full bloom by 19 days and the date of the end of flowering by 21 days.

It can thus be established that the Magyar kajszi forms showed a difference of 0—4 days in the date of the phenophase depending on the crop year. The crop year may change the date of the beginning of flowering by more than 20 days.

Table 1 compares the flowering trends of the Magyar kajszi clones in three crop years at two growing sites. The time of flowering varied with crop year and growing site alike (Table 1). At the more northerly growing site the individual phenophases set in later and were of shorter duration (except for full bloom in 1965). According to DUHAN (1944), LÖSCHNIG—PASSECKER (1954), MALIGA (1960), BRÓZIK—NYÉKI (1975), BLASSE (1976) and NYUJTÓ (1978) the varieties show the same relative order of flowering in the successive years.

However, as seen in Table 2, the varieties do not give the same response to different temperature and precipitation conditions. Some varieties (Magyar kajszi C.235/2 and C.256, Rakovszky kajszi C.333, Hetényi rózsa C.777 and Kései rózsa C.1792) usually blossomed at

flowering time in Magyar kajszi apricot clones

of flowering in the earliest clone									
5	6	7	8	9	10	11	12	13	14
13%	3%								
4%	0%	4%	2%	0%	1%				
1%	12%	22%	25%	16%	4%	4%	5%	1%	1%
9%	2%	6%	21%	2%					

13%									
45%	26%	15%	3%	3%					
19%	2%	4%	11%	0%	4%	0%	4%		
17%	42%	28%	7%	0%	1%				
13%	7%	7%	4%	2%					

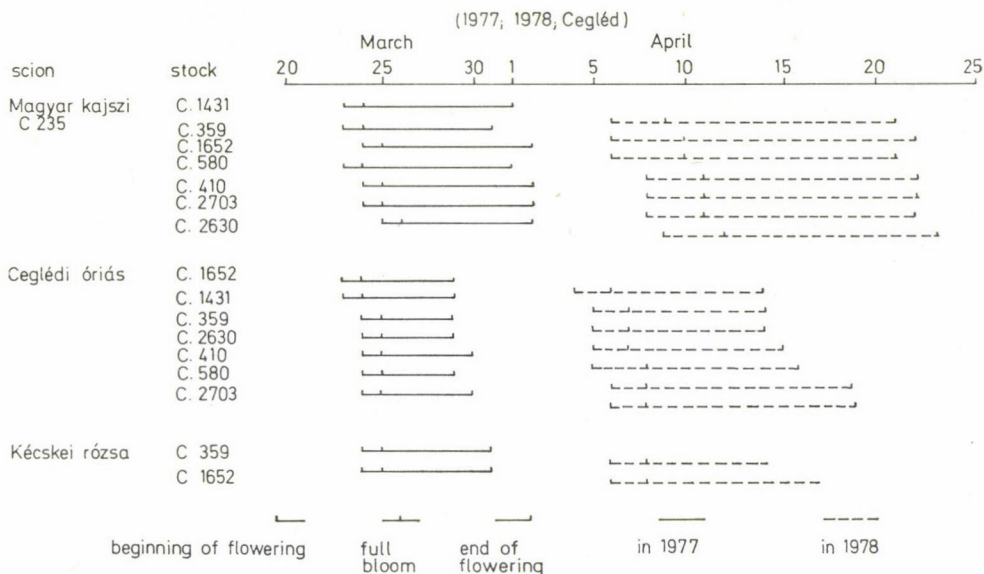


Fig. 4. Effect of root-stock on flowering time in the apricot varieties Magyar kajszi C.235, Ceglédi óriás and Kécskei rózsza (1977, 1978, Cegléd)

Table 2
Flowering time in apricot varieties
 (1964–1978, Cegléd)

Variety	Time group			Number of years examined	Time group
	early	medium	late		
C.732 kajsz	9	4	—	13	early
Ceglédi bíbor	7	6	—	13	medium early
C.326 kajsz	7	6	—	13	medium early
Korai piros C.242	4	3	—	7	medium early
Magyar kajsz C.235	5	7	1	13	medium early
Ceglédi óriás	6	4	3	13	fluctuating
Ceglédi hajnalpír	3	8	2	13	medium
Kecskeméti rózsza C.778	2	9	1	12	medium
C.333 Rakovszky	3	10	—	13	medium
C.777 Rózsabarack	1	10	2	10	medium
C.256 Magyar kajsz	—	5	1	6	medium
C.1792 Kései kajsz	—	9	1	10	medium
Magyar kajsz C.235/2	—	10	2	12	medium
Kécskei rózsza	—	6	3	9	medium late
C.1618	1	8	4	13	medium late
Mandulakajsz C.712	—	9	4	13	medium late

the same time, while in others the time of flowering showed a smaller or greater variation in successive years.

Flowering time was least stable in the variety Ceglédi óriás; in 6 of the 13 years examined it blossomed early, while on 7 occasions it flowered in some other period.

Changes in the relative order of flowering are very frequently due to extreme meteorological conditions. Therefore, to determine the time of flowering properly those crop years must be taken into consideration in which the process of flowering is neither too quick nor too slow. In such crop years the relative order of flowering is mostly constant. On the basis of the relative order of flowering the varieties can be placed in flowering time groups (Table 3).

The distribution of the varieties among the flowering time groups shows that most varieties in the present collection belong to the early and midseason categories.

The differences between the flowering time groups formed on the basis of the relative order of flowering in the apricot varieties are small, 1 to 5 days depending on the crop year. Thus, no really "late" varieties can be selected from the present commercial apricot varieties in Hungary (Fig. 2). In agreement with the literary data it was established that the differences in flowering time between the apricot varieties grown at present in Hungary are not great, though they may be increased through a suitable choice of root-stock and growing site.

In spite of the fact that the differences are not too great, the tendency of flowers to become frost-bitten decreases with the lateness of flowering (insofar as the temperature falls during the flowering time of the early varieties), as seen in Fig. 3.

Table 3
Flowering time groups for apricot varieties

Qualification	Early	Medium	Late
Varieties certified or licensed for marketing	Ceglédi bíbor* Ceglédi óriás Gönci Magyar kajszi Korai piros Magyar kajszi C.235* Szegedi mammut	Budapest Ceglédi bíbor* Ceglédi hajnalpír Ligeti óriás Magyar kajszi C.235*	Borsi-féle késői rózsza Kécskei rózsza Rakovszky kajszi
Varieties temporarily licensed for propagation	C.326 kajszi	Andornaktályai Magyar kajszi Krasznoscsokij Pozdnij Magyar kajszi C.235/2 Magyar kajszi C.256 Magyar kajszi Pécs 2 Paksi Magyar kajszi	Kecskeméti rózsza C.778 Mandulakajszi C.712
Varieties recommended for large-scale variety trials	C.732 kajszi Csongrádi kajszi Nagykőrösi óriás	Bergeron C.320 rózsabarack	
Promising varieties	Korai piros C.242	C.333 Rakovszky C.1792 Kései kajszi	Budatétényi sárga (Pécs 1) C.1646 Hetényi rózsza C.777
Old varieties	Achme Mund	Ambrózia Ananász Montgamet Nagyszombati Nancy Tivoli	Holub cukor Kaissa Kései rózsza

Note: * in some years

With the proper use of root-stocks the flowering date can be modified. Trees grafted on C.359 myrobalan and C.1652 *Prunus armeniaca* root-stocks blossom earlier, while those grafted to C.2703 *Prunus armeniaca* and C.410 *Prunus amygdalo-persica* root-stocks flower later (Fig. 4). However, the effect of root-stocks on the time of flowering varies with the variety. As seen in the figure, the root-stock does not influence all varieties to the same extent or in the same way.

The apricot varieties include self-sterile and partially self-fertile ones as well. In Fig. 5 variety pairs which flower simultaneously or do not flower at the same time, according to the established time of flowering, are seen.

When studying the flowering process from the point of view of fertilization it is found that in spite of the fact that most apricot varieties are self-fertile, the role of insects in pollination is indispensable. For insects the presence of open flowers is the important thing, while fertilization depends on the activity of the generative organs.

The microphenological characteristics of the flowers are summed up in Tables 4 and 5. The scattering of pollen (dehiscence of the anther) may begin even at the white bud stage.

Table 4
Activity of reproductive
 (1976—1978,

Stage	1976			
	Ceglédi óriás	Magyar kajszí	Kecskeméti rózsa	Kécskei rózsa
Average duration of pollen shedding (day)	1.0	2.0	1.5	1.0
Average duration of secretory activity (day)	0.5	0.5	0.5	0.5
Length of time from flower opening to the end of pollen shedding (days/flower)	1.0	2.0	1.0	1.0
Length of time from flower opening to the end of secretory activity (days/flower)	2.5	2.0	3.0	2.0
Difference in activity between the two generative organs (days)	1.5	1.0	2.0	1.0
Pollen shedding beginning at bud stage (%)	53	69	48	39
Secretory activity imperceptible (%)	51	45	43	93
Homogamy (%)	0	3	2	0
Total heat units up to flowering (°C)	301.4	301.4	301.4	310.3
Heat units used for flowering (°C)	76.3	64.6	88.8	67.4
Total precipitation up to flowering (mm)	56.8			
Precipitation during flowering (mm)	2.6			

During the dehiscence of the anther there is a pause in the secretory activity, which then starts up 1—4 days after flower opening or 0.5—2 days after pollen shedding has been completed (female precedence). Homogamy (both sexual organs functioning within a single flower) was 0% in most cases; in some years (1977) and at some sites (Cegléd) the reproductive organs became active at the same time in 2—10 and 5—20% of the flowers, respectively. The length of the active period greatly depends on the varietal traits and the air temperature during blossoming. In 1976 and 1978, when the air temperature and precipitation conditions were unfavourable, the periods of pollen shedding and secretory activity were longer (1—2 and 2—4 days, respectively) than in 1977 (0.5 and 1 day, respectively). Warm rainy weather (Cegléd, 1978) shortened the active period of the reproductive organs, while cold rainy weather prolonged it.

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Prepared at the Experimental Station of the Research Institute for Fruit-trees and Ornamentals, Cegléd; Research Institute for Fruit-trees and Ornamentals, Budapest; University of Horticulture, Department of Fruit Growing, Budapest; University of Horticulture, Department of Plant Genetics and Breeding, Budapest

F. NYUJTÓ, S. BRÓZIK J. NYÉKI, S. BRÓZIK JR.

organs in apricot varieties
Budaörs)

1977				1978			
Ceglédi óriás	Magyar kajszi	Kecskeméti rózsa	Kécskei rózsa	Ceglédi óriás	Magyar kajszi	Kecskeméti rózsa	Kécskei rózsa
0.5	1.0	1.0	1.0	1.5	1.5	1.0	2.0
0.5	0.5	0.5	0.5	1.5	1.5	0.5	0.5
0.5	0.5	0.5	0.5	1.5	1.5	1.5	2.0
1.0	1.0	1.0	1.0	2.0	2.5	2.5	4.0
0.5	0.5	0.5	0.5	0.0	1.0	1.0	2.0
40	35	100	25	15	10	6	25
60	65	65	45	11	45	18	45
5	0	0	5	0	10	5	0
357.9	357.9	357.9	357.9	316.5	326.8	326.8	316.5
40.3	45.7	47.0	47.0	41.0	42.9	51.6	53.2
72.5				65.2			
0.2				10.2			

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Table 5

*Activity of reproductive organs in apricot varieties grown at two sites
(1978, Budaörs, Cegléd)*

Stage	Budaörs				Cegléd			
	Ceglédi óriás	Magyar kajszi	Kecske- méti rózsa	Kécskei rózsa	Ceglédi óriás	Magyar kajszi	Kecske- méti rózsa	Kécskei rózsa
Average duration of pollen shedding (days)	1.5	1.5	1.0	2.0	0.5	0.5	1.0	1.0
Average duration of secretory activity (days)	1.5	1.5	0.5	0.5	1.5	1.5	1.0	1.5
Length of time from flower opening to the end of pollen shedding (days/flower)	1.5	1.5	1.5	2.0	1.5	0.5	1.0	0.5
Length of time from flower opening to beginning of secretion (days/flower)	2.0	2.5	2.5	4.0	1.5	0.5	1.0	1.0
Difference in active period between the two reproductive organs (days)	1.5	1.0	1.0	2.0	0.0	0.0	0.0	0.5
Pollen shedding beginning at bud stage (%)	15	10	6	25	6	67	16	20
Secretory activity imperceptible (%)	11	45	18	45	0	0	5	0
Homogamy (%)	0	10	5	0	0	6	26	5
Total heat units up to flowering (°C)	316.5	326.8	326.8	316.5	344.6	365.4	365.4	362.2
Heat units used for flowering (°C)	41.0	42.9	51.6	53.2	33.1	33.2	33.2	40.0
Total precipitation up to flowering (mm)	65.2				78.3			
Precipitation during flowering (mm)	10.2				13.3			

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flower opening %

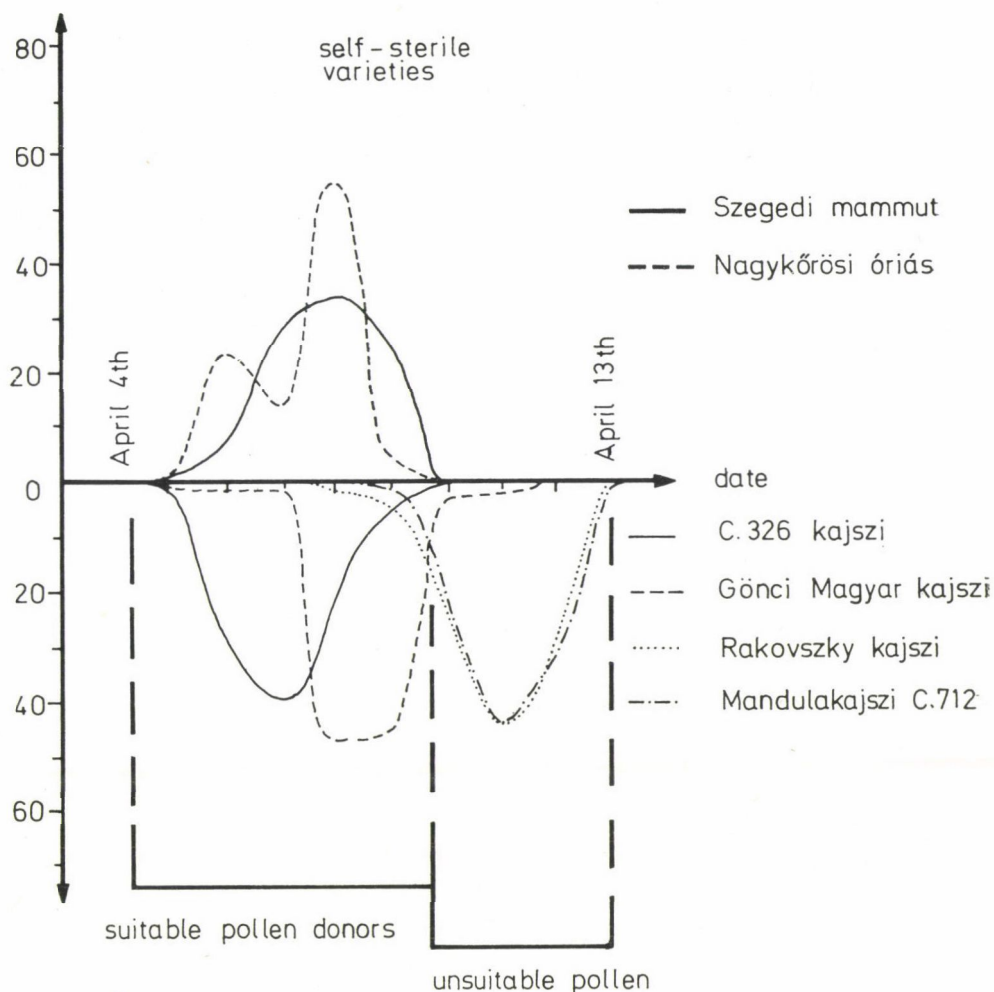


Fig. 5. Overlapping of flowering times in apricot varieties (1978, Cegléd)

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EFFECT OF THE AGE OF THE PISTIL ON THE TISSUE STRUCTURE OF THE DEVELOPING GRAIN IN CYTOPLASMIC MALE STERILE WHEATS

Although the pistil is capable of being fertilised for several days, it has been observed that pollinations carried out at different times result not only in different seed setting ratios, but also in differences in the grains which develop. RAJKI (1961) and KOVACIK—HOLIENKA (1963) found that as the number of days after emasculation increased, not only did the seed setting decrease, but the mass of the wheat grains was also reduced, indicating a reduction in the viability of the stigma. Similar results were obtained by ESIMBAYEVA (1971) in experiments on cytoplasmic male sterile wheat. ABRAMOVA (1966) and PRONSKAYA (1975) observed that the pollen tube growth rate on the stigma decreased parallel to the aging of the pistil. Previous experiments (MOLNÁR-LÁNG—RAJKI 1980) have shown that late pollination influences not only seed setting and grain mass, but also the germinating ability. Observations show that the delayed fertilisation which occurs when male sterile wheats are wind pollinated is one of the reasons for the poor germinating ability of grains developing in male sterile ears.

Histological examinations were carried out to determine the differences observable between grains developing in fertile and male sterile flowers fertilised at the beginning of flowering and those developing in male sterile flowers fertilised at the end of flowering.

The wheat variety Skorospelka 35 and its *T. timopheevi* cytoplasmic male sterile analogue were used in the experiments. Twenty fertile ears were emasculated and isolated. Ten emasculated and 10 male sterile ears were pollinated on the first day of flowering and 10 emasculated and 10 male sterile ears on the ninth day of flowering, while 10 fertile ears were self-pollinated. The developing grains were fixed in a 9 : 0.5 : 0.5 mixture of ethyl alcohol, acetic acid and formalin on the 7th day after flowering for the fertile ears and on the 7th day after pollination for the male sterile and emasculated ears, and were then stored in 70% ethyl alcohol. After embedding in paraffin, 15–20 μ longitudinal sections were prepared and stained with hematoxylin after Erlich. The photographs were taken with an Ultraphot 3 microscope manufactured by Opton.

No differences were found between grains developing in emasculated and male sterile flowers, so only samples taken from self-pollinated fertile flowers and from male sterile flowers pollinated at the beginning and the end of flowering will be discussed.

The tissue structure of grains developing in fertile flowers and in male sterile flowers pollinated at the beginning of flowering does not differ significantly (Figs 1 and 2). In both

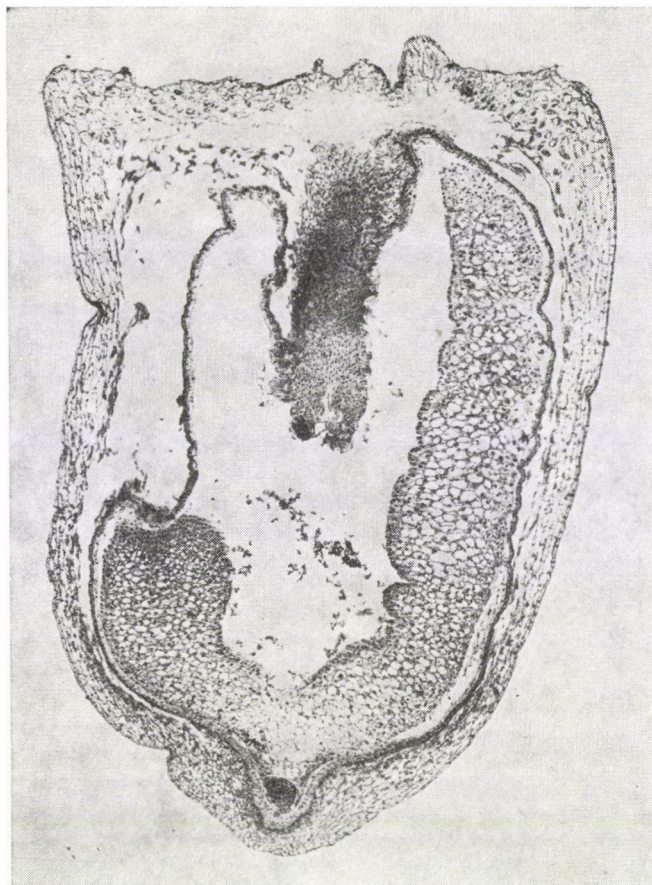


Fig. 1. Longitudinal section of grain developing from fertile flower, 7 days after flowering

cases the endosperm is similarly well developed, consisting longitudinally of approx. 80 cell-rows. The embryo is a similar shape and size in the two treatments and is at the same stage of development.

The tissue structure of grains developing in male sterile flowers fertilised at the end of flowering differs from that of grains developing in fertile flowers. In the ten samples examined the degree of deviation varies; only the two extreme cases, where the difference is least and greatest, are presented here.

In the first case the degree of development of the embryo is retarded compared to that of the embryo in grains from fertile flowers, consisting longitudinally of only half as many (approx. 40) cell-rows (Fig. 3). However, no significant difference can be observed in the shape and size of the embryo.

In the other sample, where the greatest difference was found, the volume of the endosperm is considerably smaller, 15—20 cell-rows in length, i.e. hardly a quarter of that in grains developing in fertile flowers (Fig. 4). The retardation in the development of the embryo is not so marked, however.

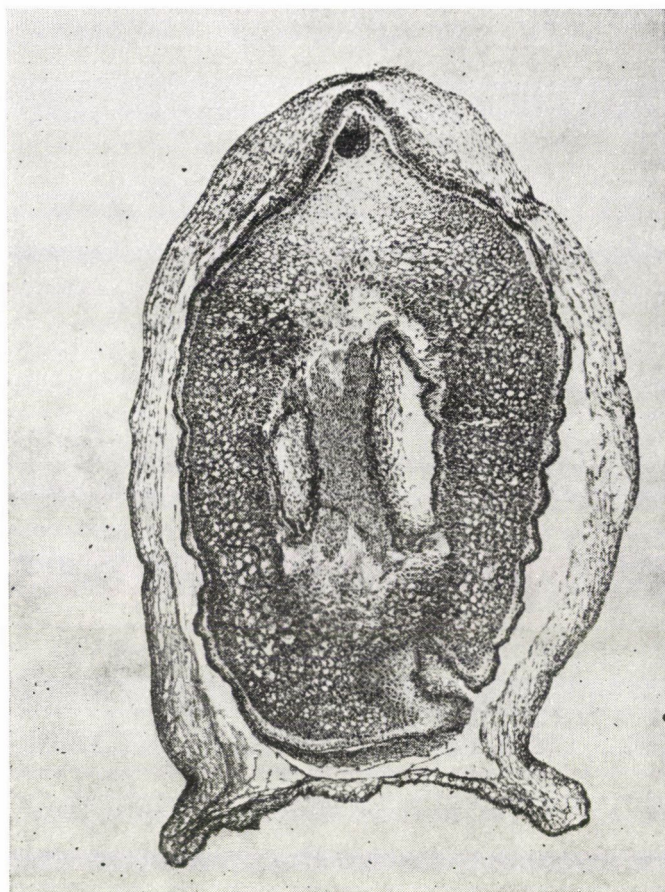


Fig. 2. Longitudinal section of grain developing from male sterile flower pollinated on the first day of flowering, 7 days after pollination

Table 1

Length and breadth of grains developing in self-pollinated fertile flowers and in male sterile flowers pollinated on the first and ninth days of flowering, 7 days after pollination

Material tested	Method of pollination	No. of days from beginning of flowering to pollination	Length Breadth					
			of developing grain, mm		μ			
					of endosperm		of embryo	
Skorospelka 35	self-pollination	0	4.9	2.9	3920	2296	267	232
Ms Skorospelka 35	artificial pollination	8	4.7	2.9	3528	2184	295	203
		Sample showing least deviation	3.8	2.8	2464	1736	247	189
		Sample showing greatest deviation	3.1	3.0	1064	1428	191	151

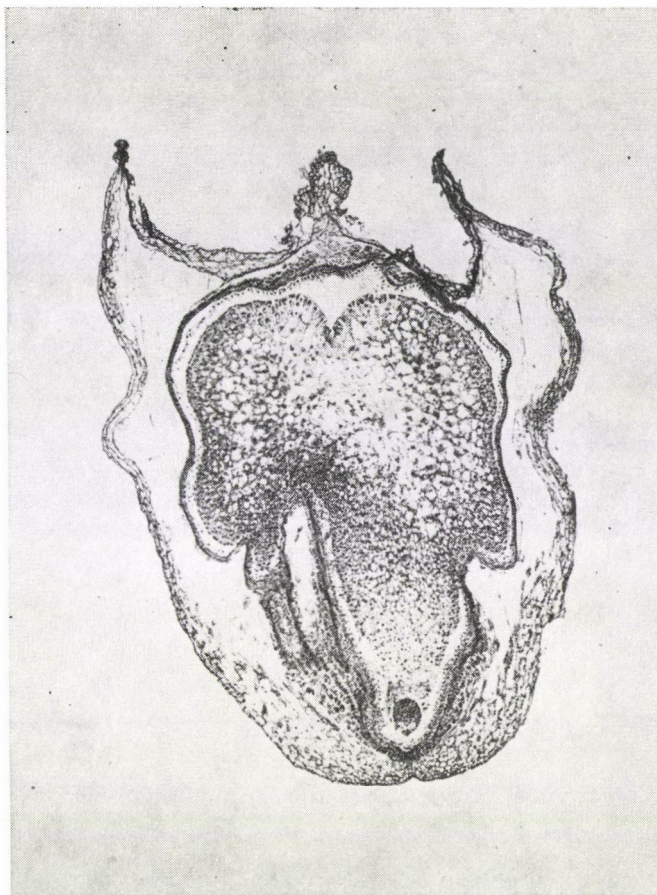


Fig. 3. Longitudinal section of grain developing from male sterile flower pollinated on the ninth day of flowering, 7 days after pollination. Sample showing least deviation from grains developing in fertile flowers

Data on the length and breadth of grains developing in fertile flowers and in male sterile flowers pollinated on the first and ninth days of flowering are presented in Table 1. There is little difference in either the length or the breadth of grains developing in fertile flowers and in male sterile flowers pollinated on the first day of flowering, but grains from male sterile flowers pollinated on the ninth day of flowering are smaller than those from fertile flowers. The differences in size between the developing wheat grains can be explained by the variations in the volume of the endosperm. Even in the sample showing the least deviation, the endosperm of grains developing in male sterile flowers pollinated on the ninth day of flowering is much smaller than that of grains developing in fertile flowers, while in the sample showing the greatest difference it is less than a third of the endosperm of wheat grains developing in fertile flowers. The embryo does not vary greatly in size from one treatment to the other. For grains developing from male sterile flowers pollinated on the ninth day of flowering the embryo is only significantly smaller than that of grains from fertile flowers in the sample showing the greatest difference.

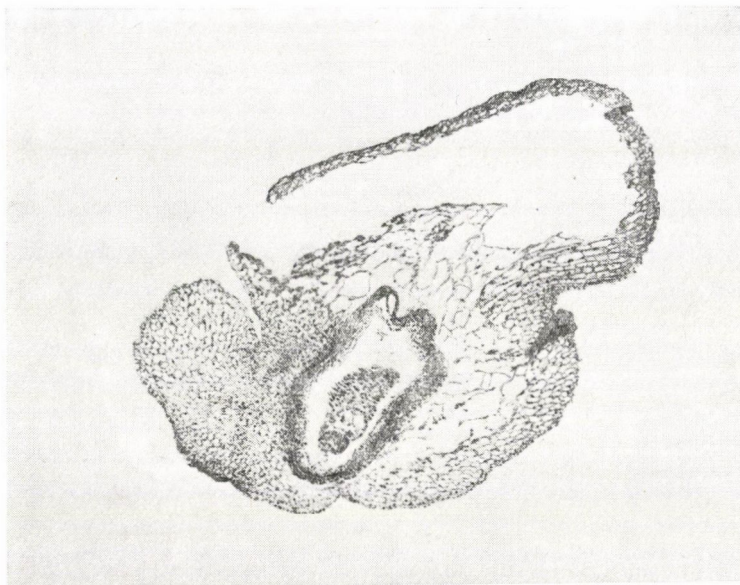


Fig. 4. Longitudinal section of grain developing from male sterile flower pollinated on the ninth day of flowering, 7 days after pollination. Sample showing greatest deviation from grains developing in fertile flowers

Thus, late pollination, or rather the age of the pistil, primarily affects the development of the endosperm. A week after pollination the endosperm of grains developing in flowers fertilised at the end of flowering has a smaller volume and consists of less cells than that of grains developing in self-pollinated flowers, thus indicating a lower intensity of cell division.

The poorer germination ability observed in previous experiments (MOLNÁR-LÁNG—RAJKI 1980) for grains developing from male sterile flowers which were fertilised late can be explained, according to the histological examinations, by the retarded development of the endosperm.

The *T. timopheevi* cytoplasm had no influence on the tissue structure of grains developing from male sterile flowers fertilised at the beginning of flowering.

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MACRO- AND TRACE ELEMENT CONTENTS IN ALFALFA

The importance of inorganic materials in fodder crops has come into prominence in recent decades. The macro- and trace element supply to farm animals and the decreased production resulting from inadequacies in this supply are dealt with in numerous works (BENTLEY—PHILLIPS 1951, MEYER—ENGELBERTZ 1960, ANKE 1959, 1965, 1971b, SCHELLNER 1969, GROPPÉL 1970, LIEDLER 1966, LÜDKE 1970, LEGG—SEARS 1960, MILLER—MILLER 1960). If the supply is to cover the requirements the mineral and trace element contents of each fodder plant must be known, together with the interrelations between the elements, which influences the utilization (KIRCHGESSNER—WESER 1967, TÖLGYESI 1969, ANKE 1971a). The trend in the inorganic content of roughage crops is a species-specific characteristic (TÖLGYESI 1969, HARASZTI—TÖLGYESI 1961, ANKE 1961, MÓCSY—TÖLGYESI 1960).

The Ca and P supply of domestic animals was studied by MAREK *et al.* (1932), and the concept of soil alkali-alkalinity (FA) which they elaborated has been adopted for feeding Ca and P in Hungary.

For a long time, studies on the mineral contents of fodder crops were restricted to the determination of Ca, P and Mg in oxides (URBÁNYI 1952). BÁNK—BÁNK-BIRÓ (1956) determined the CaO, MgO and P₂O₅ contents of alfalfa in the course of maturation. They recorded changes within each cutting and between successive cuttings. Changes in the CaO, MgO and P₂O₅ contents of grasslands during maturation were also studied by REGIUS-MÓCSÉNYI (1967).

Trace element analyses were neglected for a long time in Hungary. However, since the end of the fifties an increasing number of papers have been published on the subject. Data on trace elements in roughage crops have been presented by MÓCSY—TÖLGYESI (1969), on the importance of the trace elements found in acidic grasses by HARASZTI—TÖLGYESI (1961), on the molybdenum content of sweet grasses by HARASZTI—TÖLGYESI (1962) and on the microelement content of the vegetation of alkali soils by MODOR—TÖLGYESI (1965).

SZENTMIHÁLYI (1963) was the first to study the macro- and trace element levels in cattle from the point of view of feeding. He examined sunflower and peas grown on various soils at different stages of development, and found the mineral and trace element contents of plants to be dependent on the developmental stage and the soil. He subsequently analysed alfalfa grown on 9 different types of soil. The amount of the individual elements changed with the type of soil. According to the results of his analyses, the amount of calcium in sandy and alkali soils is small, there is an abundance of sodium in alkali soils, and marshy soils contain little zinc, manganese or copper, but a large quantity of molybdenum. The author establishes as a general fact that the sodium, manganese, and in many cases the copper contents of alfalfa are low, so these elements should be supplemented to a greater or lesser extent, irrespective of the growing site.

The present investigations are intended to contribute to these data.

Table 1
Macroelement content in alfalfa grown on different soils

		Ca	Mg	P	K	Na
Sandy soil, non-acid	g/kg \bar{x}	13.3	2.5	2.9	28.4	0.82
	$\pm s$	1.7	0.2	0.4	5.6	0.30
	$\bar{V}^0_{/o}$	13.2	9.2	14.7	19.5	34.10
	h_1	11.9	2.3	3.5	23.9	1.04
	h_2	14.7	2.7	3.2	32.9	1.04
Sandy soil, acid	g/kg \bar{x}	12.9	2.9	3.3	39.0	0.46
	$\pm s$	2.9	1.1	0.6	9.0	0.20
	$\bar{V}^0_{/o}$	22.6	37.3	19.2	22.9	33.10
	h_1	10.7	2.1	2.8	32.2	0.34
	h_2	15.1	3.7	3.8	45.8	0.57
Chernozem brown forest soil	g/kg \bar{x}	15.3	3.6	3.5	35.5	0.85
	$\pm s$	4.0	0.9	0.5	12.4	0.60
	$\bar{V}^0_{/o}$	26.2	23.8	15.8	34.8	66.10
	h_1	12.8	3.1	3.1	27.7	0.49
	h_2	17.8	4.1	3.8	43.3	1.21
Brown forest soil with clay infiltration	g/kg \bar{x}	17.8	3.0	3.5	26.3	0.71
	$\pm s$	3.6	0.9	0.7	10.0	0.30
	$\bar{V}^0_{/o}$	20.2	30.7	19.3	37.7	42.00
	h_1	16.2	2.6	3.2	22.1	0.58
	h_2	19.3	3.4	3.7	30.5	0.84
Compact chernozem soil	g/kg \bar{x}	19.1	3.2	3.3	33.7	0.76
	$\pm s$	2.4	1.2	0.6	7.2	0.30
	$\bar{V}^0_{/o}$	12.6	38.6	19.5	21.4	37.40
	h_1	18.1	5.7	3.0	30.8	0.65
	h_2	20.1	3.7	3.5	36.5	0.88
Sandy meadow soil	g/kg \bar{x}	12.6	3.5	3.2	35.3	0.76
	$\pm s$	2.2	1.7	0.4	9.4	0.30
	$\bar{V}^0_{/o}$	17.6	49.4	13.6	26.6	40.10
	h_1	10.6	2.0	2.8	26.9	0.49
	h_2	14.6	5.1	3.6	43.7	1.03
Compact meadow soil	g/kg \bar{x}	17.6	3.5	3.4	32.0	0.96
	$\pm s$	3.3	1.3	0.5	7.6	0.60
	$\bar{V}^0_{/o}$	18.5	37.6	20.9	23.6	58.30
	h_1	15.5	2.6	2.9	27.0	0.58
	h_2	19.8	4.3	3.9	37.0	1.33
Meadow alluvial soil	g/kg \bar{x}	14.5	3.2	3.5	36.3	0.78
	$\pm s$	2.3	1.1	0.5	10.5	0.30
	$\bar{V}^0_{/o}$	15.8	34.1	14.8	28.9	39.10
	h_1	12.6	2.2	3.0	27.8	0.50
	h_2	16.3	3.9	3.9	44.9	1.00
Clayey alluvial soil	g/kg \bar{x}	17.7	2.8	2.9	24.1	0.91
	$\pm s$	1.9	0.9	0.6	8.8	0.30
	$\bar{V}^0_{/o}$	10.9	32.3	19.9	36.5	33.40
	h_1	16.4	2.3	2.5	18.5	0.72
	h_2	18.9	3.4	3.2	29.6	1.10
Tisza alluvium	g/kg \bar{x}	9.8	4.4	3.3	27.3	0.70
	$\pm s$	1.5	0.5	0.4	6.9	0.10
	$\bar{V}^0_{/o}$	15.4	10.3	12.6	25.3	11.70
	h_1	8.3	3.9	2.9	20.4	0.62
	h_2	11.3	4.9	3.7	34.1	0.78

Table 1. continued

		Ca	Mg	P	K	Na
Alkali soil	g/kg \bar{x}	10.1	4.9	3.0	38.9	2.74
	$\pm s$	3.5	1.0	0.4	8.1	0.70
	V%	34.4	19.5	12.8	20.9	25.90
	h_1	7.8	4.2	12.8	33.5	2.24
	h_2	12.4	5.5	3.3	44.3	3.22
Marshy soil	g/kg \bar{x}	14.1	2.8	3.2	36.4	0.83
	$\pm s$	2.9	0.8	0.6	12.6	0.40
	V%	20.5	27.2	19.7	34.7	50.20
	h_1	12.3	2.3	2.8	58.4	0.57
	h_2	15.9	3.3	3.6	44.4	1.09

Since 1970 samples of the first growth of alfalfa have regularly been collected at the budding stage from places with different soil conditions in Hungary, and these areas have been put in 12 soil categories according to the soil classification given by STEFANOVITS (1963).

For the determination of minerals and trace elements, 10 g of each of the dried samples was reduced to ashes. Calcium, magnesium, copper, zinc and manganese were determined by atom absorption spectrophotometry, with the aid of standard curves. Sodium and potassium were determined using the same apparatus, but by flame photometry, again with the aid of standard solutions. The phosphorus analysis was carried out using the colour response in a Spekol.

The other part of the work consisted of examining 314 samples of alfalfa varieties grown on the same soil type. The Agrobotanical Institute at Tápíósele provided samples of the first and second growth of 157 alfalfa varieties (a total of 314 samples). These alfalfa samples were prepared and analysed in the manner described above. The crude protein data of alfalfa samples from the first cutting were obtained from the Agrobotanical Institute.

The g/kg values of minerals in the alfalfa samples collected from various soils (\bar{x}), the standard deviation ($\pm s$), the variation percentages (V %) and the lower and upper values of confidence (h_1 and h_2) for 12 soil types are summarized in Table 1.

The average values of calcium content in the alfalfa samples ranged from 9.8 to 19.1 g/kg depending on the soil. The extreme values were 7 and 24.2 g/kg. The smallest amount of calcium was found in alfalfa grown on the alluvium of the river Tisza, and the largest amount in those from a compact chernozem soil. The magnesium content varied from 2.5 to 4.9 g/kg. The phosphorus values ranged between relatively narrow limits (2.9 and 3.5 g/kg). Alfalfa samples obtained from alkali soils contained the highest amounts of sodium (2.74 g/kg on average; highest measured value 4.0 g/kg). These are four and six times, respectively, the average amount (0.7 g/kg) quoted in the literature. The lowest amount of sodium (an average of 0.46 g/kg) was found in alfalfa grown on acidic sand; the lowest measured value was 0.2 g/kg. These data agree in tendency with the values obtained earlier by SZENTMIHÁLYI (1966). On alkali soils MODOR-TÖLGYESI (1965) found as much as 50 g/kg sodium in some halophytic plants.

According to Table 2, which contains the average values, the variance, the variation percentage (V%) and the h_1 and h_2 data for trace elements, the smallest amounts of copper are found in alfalfa grown on marshy soils and acidic sands (\bar{x} = 7.4 and 8.3 mg/kg, respectively). The amount of copper contained in alfalfa samples from marshy soils was sometimes as low as 4 mg/kg. In alfalfa grown on a compact chernozem soil the maximum amount of copper measured was 27 mg/kg.

Table 2
Trace element content in alfalfa grown on various soils

		Cu	Zn	Mn
Sandy soil, non-acid	mg/kg \bar{x}	9.4	28.0	22.0
	$\pm s$	2.3	4.3	3.7
	$\bar{V}\%$	24.4	15.5	16.8
	h_1	7.5	24.5	19.0
	h_2	11.3	31.5	25.0
Sandy soil, acid	mg/kg \bar{x}	8.3	27.6	46.3
	$\pm s$	2.2	10.3	13.9
	$\bar{V}\%$	25.8	37.4	30.1
	h_1	6.7	19.8	35.8
	h_2	9.9	35.4	56.8
Chernozem brown forest soil	mg/kg \bar{x}	12.2	28.0	21.8
	$\pm s$	4.1	5.4	5.1
	$\bar{V}\%$	33.4	19.3	23.2
	h_1	9.6	24.6	18.6
	h_2	14.8	31.4	25.0
Brown forest soil with clay infiltration	mg/kg \bar{x}	12.4	29.0	27.1
	$\pm s$	4.0	6.5	9.7
	$\bar{V}\%$	32.1	22.4	35.6
	h_1	10.7	26.2	23.0
	h_2	14.1	31.8	31.2
Compact chernozem soil	mg/kg \bar{x}	15.6	31.3	29.4
	$\pm s$	5.7	5.6	6.5
	$\bar{V}\%$	36.4	17.7	22.1
	h_1	13.4	29.1	26.7
	h_2	17.9	33.6	31.9
Sandy field soil	mg/kg \bar{x}	8.8	22.8	23.8
	$\pm s$	4.4	8.3	6.2
	$\bar{V}\%$	50.4	36.5	26.0
	h_1	4.8	15.4	18.3
	h_2	12.8	30.3	29.3
Compact meadow soil	mg/kg \bar{x}	12.3	31.0	19.9
	$\pm s$	3.6	10.3	6.1
	$\bar{V}\%$	29.5	33.1	30.8
	h_1	9.9	24.2	15.8
	h_2	14.8	37.8	24.0
Alluvial meadow soil	mg/kg \bar{x}	15.0	30.2	24.8
	$\pm s$	3.8	6.4	8.2
	$\bar{V}\%$	25.3	21.1	33.1
	h_1	11.9	25.0	18.1
	h_2	18.1	35.4	31.5
Clayey alluvium	mg/kg \bar{x}	10.2	26.5	20.2
	$\pm s$	1.5	3.7	9.0
	$\bar{V}\%$	15.2	14.0	44.5
	h_1	9.2	24.1	14.5
	h_2	11.2	28.9	25.9
Tisza alluvium	mg/kg \bar{x}	16.8	34.3	19.0
	$\pm s$	2.5	5.9	8.1
	$\bar{V}\%$	14.9	17.3	42.5
	h_1	14.3	28.3	10.9
	h_2	19.3	40.2	27.1

Table 2. continued

		Cu	Zn	Mn
Alkali soil	mg/kg \bar{x}	15.1	27.8	16.8
	$\pm s$	2.5	6.6	1.9
	$\bar{V}^0/\%$	16.7	23.9	11.5
	h_1	13.4	23.4	15.5
	h_2	16.8	32.2	18.1
Marshy soil	mg/kg \bar{x}	7.4	30.3	20.7
	$\pm s$	1.9	7.2	5.5
	$\bar{V}^0/\%$	25.6	23.8	26.6
	h_1	6.2	25.7	17.2
	h_2	8.6	34.9	24.2

The zinc content of alfalfa grown on acidic sand was far lower than that found by SZENTMIHÁLYI (1966) on a similar type of soil. According to TÖLGYESI (1969) "internal and external factors can only exercise a relatively slight influence on the zinc content". In the opinion of this author the botanical composition of meadow and pasture grasses and the soil on which they are grown do not have much effect on the amount of zinc; the values obtained are all about 25–30 mg/kg. The zinc values determined for different soil types in the present alfalfa analyses seem to confirm this statement. The mean value of zinc analyses, on the average of all soil types, is 29 mg/kg, somewhat lower than the data given in the literature (NEHRING *et al.* 1970, DRESSLER 1974, ANKE 1960, SZENTMIHÁLYI 1966). The average values of manganese range between 16.8 and 46.3 mg/kg according to the soil types.

Alfalfa grown on alkali soils contains the lowest amount of manganese (16.8 mg/kg on average). The lowest value of manganese was not found on alkali soil, however, but on calcareous alluvial soil, where alfalfa plants with a manganese content as low as 5 mg/kg were found. Alfalfa grown on meadow and marshy soils is also poor in manganese (19–20 mg/kg on average). Alfalfa grown on acidic sand is the richest in manganese; an average of 46.3 mg/kg (maximum 80 mg/kg) was found on this soil. As far as trends are concerned, the results of the manganese analyses agree with the data in the literature (SZENTMIHÁLYI 1966); but while some literary sources give the average manganese content of alfalfa as 40–50 mg/kg (KIRCHGESSNER *et al.* 1963), in the present study it was around 30 mg/kg or even below this figure. ANKE (1962) found similar manganese contents in alfalfa plants.

There are significant differences in the calcium, magnesium, potassium, sodium, copper and manganese contents of alfalfa plants grown on different types of soil. According to the data of variance analysis presented in Table 3, significant differences are found between the different soil types. With regard to the amounts of phosphorus and zinc, on the other hand, the soil types do not show characteristic differences.

The analytical results for the 157 alfalfa varieties are summarized in Table 4. According to the data in the table there were certain differences between the yields of the first and second cuttings. The ash content and the quantities of calcium, potassium, copper and manganese were larger in the second cutting, while the magnesium, phosphorus, sodium and zinc contents were higher in the first cutting. On the basis of the analytical results for the individual elements, no significant differences could be observed between the varieties. Considerable differences were found between the varieties with respect to the sodium content, probably due partly to their different capacities for sodium uptake and also because the different potassium contents influence the quantity of sodium, as confirmed by the different composition of the plant material obtained from the two cuttings.

Table 3

Variance analysis of macro- and trace element contents in alfalfa grown on various soils

	MQ	Calculated F-value	Level of significance
Ca	95.288 8.681	10.976	***
Mg	3.574 1.081	3.474	***
P	0.405 0.357	1.135	—
K	257.409 85.423	3.013	**
Na	3.062 0.153	20.040	***
Cu	89.183 15.288	5.833	***
Zn	54.552 44.918	1.214	—
Mn	481.960 58.033	8.305	***

$P = 5\% - 1.88^*$, $P = 1\% - 2.43^*$, $P = 0.1\% - 3.02$

While in the first cutting the potassium content in the 157 alfalfa varieties was generally lower and the sodium content higher, the opposite was found in the second cutting. The differences are not constant, but the tendency is similar to results presented in the literature (HENNIG—ANKE 1966). The higher calcium content is accompanied by a lower zinc content in the second cutting, while in the first cutting the situation is reversed: the calcium content is lower and the zinc content higher.

The higher ash content is associated with a higher manganese content in the second cutting. At the same time, a higher calcium value is accompanied by a lower quantity of phosphorus, and the latter by a higher manganese content. The positive correlations between manganese and zinc (ANKE 1962, SZENTMIHÁLYI 1966) and between copper and phosphorus could not be demonstrated in the present experiment; nor was the negative correlation between copper and manganese expressed. This is possibly due to the low individual variation, which is a consequence of using the same type of soil.

Thus, on the same type of soil the alfalfa varieties take up nearly identical quantities of macro- and trace elements; although there is some difference between the first and second growth in the quantities of the individual elements, this difference is not significant.

Table 5 is designed to show whether there is any correlation between the crude protein content and the amounts of the individual elements. As seen from the results, such correlations could not be demonstrated in this experiment.

On the basis of percentage crude protein contents the alfalfa varieties were divided into 5 groups. Alfalfa varieties in the first group contained 18% crude protein, while those in the second, third, fourth and fifth groups contained 18—19%, 19—20%, 20—21% and over 21% crude protein, respectively.

Table 4

Ash and mineral content in the first and second growths of various alfalfa varieties grown on the same soil, and crude protein content in the first growth

		Number of varieties	\bar{x}	$\pm s$	V%	h_1	h_2
Ash, g/kg	I	157	8.9	1.1	12.5	8.7	9.0
	II	157	9.4	1.0	10.2	9.3	9.6
Ca, g/kg	I	157	14.5	3.0	20.9	14.1	15.0
	II	157	15.3	3.3	21.2	14.8	15.9
Mg, g/kg	I	157	4.5	1.2	27.0	4.3	4.7
	II	157	4.0	0.8	19.3	3.9	4.2
P, g/kg	I	157	2.9	0.4	13.5	2.8	2.9
	II	157	2.7	0.3	12.3	2.6	2.7
K, g/kg	I	157	24.1	9.2	37.9	22.7	25.6
	II	157	24.5	7.3	30.0	23.3	25.6
Na, g/kg	I	157	1.7	0.9	56.0	1.5	1.8
	II	157	1.6	1.0	62.6	1.5	1.8
Cu, mg/kg	I	157	10.4	3.6	34.6	9.9	11.0
	II	157	11.2	2.5	22.7	10.8	11.6
Zn, mg/kg	I	157	22.6	4.3	19.0	21.9	23.2
	II	157	21.7	3.0	13.6	21.2	22.2
Mn, mg/kg	I	157	29.0	6.2	21.3	28.0	31.0
	II	157	33.3	8.6	25.7	32.0	35.0
Crude protein, %	I	157	19.9	1.2	5.9	19.7	20.1

I = first growth, II = second growth

In Table 6 the crude ash content and the amounts of macroelements it contains in the first growths of alfalfa varieties are grouped according to the crude protein content. The table contains the average values of ash, calcium, magnesium, phosphorus, potassium and sodium (\bar{x}), their variance ($\pm s$), the V% values, and the lower and upper values of confidence. The quantity of ash is given as a %, and those of the macroelements in g/kg. The ash content is the highest (9.2%) in alfalfa varieties containing 20–21% crude protein, and with the exception of sodium they contain the largest quantities of macroelements, too. Since the leaves contain more ash and minerals than the stalks, the leaf-stalk ratio in these varieties appears to have shifted in favour of the leaves, as is also proved by the crude protein content (TÖLGYESI 1969, ANKE 1960, SZENTMIHÁLYI 1963). In the group where the crude protein content of alfalfa is over 21% the slightly lower averages for ash and minerals are probably due to the small number of samples.

The trace element contents of alfalfa varieties grouped by crude protein content are shown in Table 7. The manganese content is the highest in the group with 20–21% crude protein. Changes in the zinc content do not seem to be in correlation with the other factors. The highest average copper content was found in the group with the lowest crude protein

Table 5

*Correlation between crude protein and minerals
in various alfalfa varieties grown on the same soil*

	Number of varieties	Correlation coefficient
Crude protein, % — Ash	157	0.135
Crude protein, % — Ca	157	0.129
Crude protein, % — Mg	157	0.068
Crude protein, % — P	157	0.077
Crude protein, % — K	157	0.133
Crude protein, % — Na	157	0.058
Crude protein, % — Cu	157	0.123
Crude protein, % — Zn	157	0.116
Crude protein, % — Mn	157	0.162

Lower limit of significance value ($P = 9\%$) = 0.163

Table 6

*Ash and mineral contents of various alfalfa varieties grown on the same soil,
grouped according to their crude protein contents*

Crude protein, %		Ash	Ca	Mg	P	K	Na
18	g/kg \bar{x}	8.6	14.2	4.7	2.8	22.0	1.7
	$\pm s$	1.2	1.6	1.1	0.5	9.8	0.5
	$\bar{V}\%$	13.5	11.6	22.8	16.8	44.7	29.3
	h_1	8.3	13.7	4.4	2.6	19.1	1.6
	h_2	9.0	14.7	5.1	2.9	24.9	1.9
18—19	g/kg \bar{x}	8.7	14.9	4.3	2.7	23.3	1.6
	$\pm s$	0.8	2.8	1.1	0.4	7.6	0.9
	$\bar{V}\%$	9.6	18.9	24.9	14.9	32.6	57.8
	h_1	8.5	14.3	4.1	2.7	21.8	1.4
	h_2	8.9	15.4	4.5	2.9	24.8	1.7
19—20	g/kg \bar{x}	8.8	14.6	4.4	2.8	22.4	1.7
	$\pm s$	1.0	3.1	1.0	0.4	6.9	0.8
	$\bar{V}\%$	11.3	21.4	23.6	12.3	31.1	50.5
	h_1	8.6	14.2	4.3	2.8	21.4	1.6
	h_2	8.9	15.1	4.6	2.9	23.4	1.8
20—21	g/kg \bar{x}	9.2	15.1	4.5	2.9	27.0	1.3
	$\pm s$	1.2	3.1	1.4	0.4	10.4	8.8
	$\bar{V}\%$	13.1	20.3	30.3	13.1	38.6	60.7
	h_1	9.0	14.6	4.3	2.9	25.4	1.2
	h_2	9.4	15.4	4.7	3.0	28.5	1.5
21	g/kg \bar{x}	8.8	13.3	4.9	2.8	24.2	2.1
	$\pm s$	1.3	3.3	1.5	0.4	10.9	1.2
	$\bar{V}\%$	15.1	24.7	29.7	13.5	45.0	55.7
	h_1	8.6	12.7	4.6	2.7	22.2	1.8
	h_2	9.1	13.9	5.1	2.9	26.3	2.3

Table 7

Trace element contents of various alfalfa varieties grown on the same soil, grouped according to their crude protein contents

Crude protein, %		Cu	Zn	Mn
18	mg/kg \bar{x}	11.4	22.5	27.0
	$\pm s$	3.5	4.2	5.5
	$\bar{V}\%$	31.3	18.8	20.6
	h_1	10.3	21.2	25.4
	h_2	12.4	23.7	28.7
18—19	mg/kg \bar{x}	10.6	22.5	28.7
	$\pm s$	4.9	3.6	5.0
	$\bar{V}\%$	46.9	16.2	17.5
	h_1	9.6	21.8	27.6
	h_2	11.5	23.2	29.6
19—20	mg/kg \bar{x}	10.4	23.4	27.6
	$\pm s$	3.3	4.3	4.9
	$\bar{V}\%$	31.7	18.5	17.9
	h_1	9.9	22.8	26.8
	h_2	10.8	23.9	28.2
20—21	mg/kg \bar{x}	10.5	22.8	30.5
	$\pm s$	3.5	4.0	7.5
	$\bar{V}\%$	23.8	17.7	24.6
	h_1	10.0	22.2	29.3
	h_2	11.0	23.4	31.6
21	mg/kg \bar{x}	9.9	20.7	30.1
	$\pm s$	2.7	4.8	6.5
	$\bar{V}\%$	27.9	23.3	21.8
	h_1	9.4	19.8	28.8
	h_2	10.5	21.6	31.3

content. Parallel to a rise in the crude protein content there is a reduction in the amount of copper.

It is a well known fact that protein synthesis requires molybdenum. The rhizobium bacteria need molybdenum to bind the nitrogen. ANKE (1962) found a positive correlation between molybdenum content and crude protein level in alfalfa and red clover. TROBISCH—GERMAR (1959) arrived at the same conclusion in experiments with cauliflower. TÖLCYESI (1969) also found a positive correlation between the crude protein and molybdenum contents of plants. Copper and molybdenum are antagonistic elements: the incorporation of copper into the plant is inhibited by molybdenum. Copper and molybdenum are in close metabolic relationship. Accordingly, alfalfa varieties with a higher crude protein content presumably take up more molybdenum, thus reducing the amount of copper they contain. It is thus planned to broaden the scope of the present investigations to include the determination of molybdenum in alfalfa varieties. This has not been done so far since the facilities required for the instrumental determination of molybdenum, and the personnel necessary for the very time-consuming procedure of chemical determination are not available.

Table 8 contains the variance analysis of alfalfa varieties, grouped according to crude protein content, for the different macro- and trace elements. No significant difference was found between the groups.

Table 8

*Variance analysis of various alfalfa varieties grown
on the same soil, grouped according
to their crude protein contents*

	MQ	Calculated value	Level of significance
Ash	1.459 1.226	1.191	—
Ca	15.459 9.063	1.706	—
Mg	1.423 1.491	0.954	—
P	0.153 0.150	1.018	—
K	140.391 82.357	1.705	—
Na	2.680 0.819	3.273	*
Cu	4.500 13.242	0.340	—
Zn	31.363 17.950	1.747	—
Mn	68.462 37.251	1.838	—

$$P = 5\% = 2.43, * P = 1\% = 3.44, ** P = 10\% = 1.99$$

Substantial differences in macro- and trace element content are found between alfalfa varieties grown on different types of soils. The amounts of the elements examined show significant differences, except for phosphorus and zinc. This is due to the variation in pH and mineral content of the soils.

The investigations show that alfalfa grown on soils rich in lime generally contains more copper and manganese than that grown on alluvial, alkali and marshy soils. The largest amount of manganese is found in alfalfa plants grown on acidic sand, because only Mn II can be taken up from the soil by the plant, and with an acidic pH the proportion of available manganese is higher than in the case of neutral or alkaline soil reactions.

The results of investigations reveal that in a feeding system where alfalfa represents a considerable proportion of the daily feed rations for ruminants, even alfalfa varieties grown on alluvial, alkali or marshy soils add enough calcium to the feed to make calcium supplements superfluous in the majority of cases.

Alfalfa plants grown on different soils do not show a wide variation in phosphorus content, and, as is characteristic of legumes, contain little phosphorus. The latter is also true of manganese, although the manganese content of the alfalfa plant varies greatly with the soil type.

There are no significant differences in macro- and trace element content between alfalfa varieties grown on the same soil. The second growth of alfalfa contains more ash components,

calcium, potassium, copper and manganese, and somewhat less magnesium, phosphorus, sodium and zinc than the first growth.

No correlation was found between the crude protein content and the amounts of minerals in the alfalfa varieties in any case. This suggests that the crude protein content and the minerals examined are variables which act independently from one another. The copper content shows a slightly different trend: with an increase in the crude protein content it shows a slight, non-significant reduction. From the trends of macro- and trace elements contained in the large number of alfalfa varieties examined it can be concluded that no significant differences can be expected in the mineral contents of the individual varieties.

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EFFECT OF CYCLODEXTRIN TREATMENT ON THE DEVELOPMENT AND YIELD OF WHEAT

In the intensive cereal production programme an increasing role is being given to testing every procedure or material aimed at attaining record yields. In addition to varieties with excellent productivity and cultural practices which ensure a balanced nutrient supply, the elaboration of stimulating treatments which can be used in production systems is also dealt with in many papers. Results which can be applied in practice can only be obtained after extensive screening tests on harmless, cheap molecules which always produce the same effect.

In cereal production stimulative seed treatments have been carried out for a number of years. For this purpose microelements, vitamins, growth hormones, etc. have generally been used. In the last decade significant positive results have only been achieved with CCC (chlorocholine-chloride, Cycocel) (RADNEV 1977, EL-SHARKAWY *et al.* 1978, GARMASKOV—SELIVANOV 1978, STRASS—MÜNZER 1979, ZIMOVA 1979).

Owing to concern about the use of chlorocholine-chloride and the strict measures regulating its use in some countries, there is every justification for investigating other mole-

cules. The present paper gives an account of the results obtained in grain treatments with cyclodextrin.*

Many interesting effects of cyclodextrins have already been described (SZEJTLI 1982), and they are used industrially in a variety of ways. However, nothing has been published yet on their effect on the physiology of plants and, above all, on their application in agriculture.

In the phytotron of the Agricultural Research Institute of the Hungarian Academy of Sciences, Martonvásár, Siete Cerros 66 spring wheat plants were raised on a conventional climatic programme for cereal production until harvest.

The grains were soaked for 24 hours in α - or β -cyclodextrin, or in a linear dextrin solution, then washed and planted individually in pots (in the course of this treatment the wheat seed takes up an amount of β -cyclodextrin corresponding to about 2‰ of its mass, according to the results of measurements with C^{14} -labelled material).

Some of the plants were evaluated at the age of 4 weeks on the basis of their vegetative growth. The remainder were harvested at maturity, at the age of 4 months. The latter were evaluated on the basis of the following yield components: plant height, tillering, number of spikes per plant, length of spike, number of grains per spike, number of spikelets, grain mass per plant and thousand-grain-mass. The experiment was performed in four replications; the number of examined plants ranged from 8 to 18 per series. The individual data were mathematically processed. After determining the significance of certain experiments and finding that the experiments showed an identical tendency, conclusions were drawn on the effect of the cyclodextrin seed treatment.**

The effect of cyclodextrin treatment on germination can be seen from the data in Table 1. Seedlings show the greatest extent of growth inhibition at the age of 3 days in response to α -cyclodextrin, and at the age of 6 days when β -cyclodextrin is used for seed treatment. The significantly higher retarding effect of cyclodextrins compared to linear dextrans is obvious in every case.

Figure 1 clearly shows that at the age of 3, 4 and 5 days the plants (marked BCD) are smaller than the control; they begin to catch up with the control plants at 9 days old, while at the age of 13 days they exceed them in height, and some leaves are also broader (Fig. 1).

Detailed length and mass data for 4 week old plants raised in a phytobox are contained in Table 2. The growth stimulation induced by the cyclodextrin treatment was significant primarily in the root: an increase of >10% in longitudinal growth and >30% in dry mass.

Of the yield components measured at harvest, the two considered to be the most important in determining the yield, and which were also found to show the highest significant difference in favour of the treatment, are included in Table 3. The results showed the same tendency and limit values in all four replications. The significance of the individual data is shown by the values of differences which proved significant even at the 0.1% level. For instance in response to the cyclodextrin treatment the extent of tillering increased by >30% and the yield per plant by >40%.

A possible starting point for the explanation of this phenomenon is the well-known fact that cyclodextrins induce competitive inhibition of β -amylase activity (THOMA—KOSHLAND 1960).

* Synonyms are: Schardinger-dextrin, or cyclo-hexa-, hepta-, or octaamylose (a macro ring consisting of 6, 7 or 8 glucopyranose units); it is formed from starch under the influence of cyclodextrin-transglucosylase enzyme. The main characteristic of cyclodextrins is that they form crystalline inclusion complexes with a number of materials (= guest molecules). Complex formation may alter the properties of the guest molecule.

** These results were confirmed by field data, an account of which was given at the 20th Hungarian Annual Meeting for Biochemistry (TÉTÉNYI—SZEJTLI 1980).

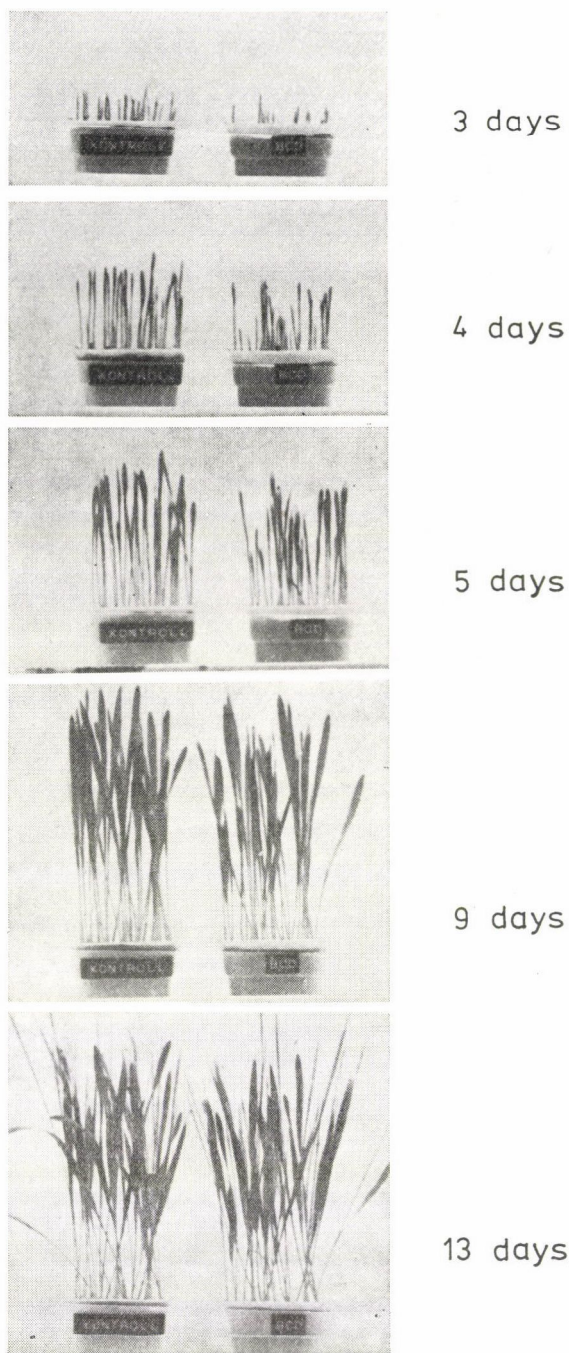


Fig. 1. Effect of treatment with cyclodextrin on the germination of wheat seeds and the growth and development of seedlings

Table 1

*Initial growth inhibition caused by cyclodextrins in barley seedlings
(summarized data of 30 plants)*

	3 days old		6 days old	
	root mm (Δ%)	shoot mm (Δ%)	root mm (Δ%)	shoot mm (Δ%)
Control	5123	662	7714	2090
Linear dextrin	2620 (−25.0)	474 (−28.4)	4625 (−40.1)	1568 (−48.8)
α-cyclodextrin	1056 (−79.4)	96 (−85.5)	2593 (−66.4)	754 (−63.9)
β-cyclodextrin	1808 (−64.7)	191 (−71.2)	2277 (−70.5)	556 (−73.4)
LSD _{5%}	900.6	124.3	814.4	223.9

Table 2

*Effect of cyclodextrin treatment on the vegetative growth of spring wheat at the age of 4 weeks
(phytotron experiments, Martonvásár)*

	Roots/plant		Shoots/plant	
	length cm (Δ%)	dry mass g (Δ%)	length cm (Δ%)	dry mass g (Δ%)
Control	33.95	0.061	29.55	0.238
β-cyclodextrin	38.40 (+13.1)	0.081 (+32.8)	31.83 (+7.7)	0.281 (+18.1)
LSD _{5%}	1.63	0.019	2.26	0.049

Table 3

*Yield response of 4-month old spring wheat plants
to cyclodextrin seed treatment
(phytotron experiments, Martonvásár)*

Treatment	Spikes/plant	Grain mass/plant
	No. (Δ%)	g (Δ%)
Control	2.8	4.15
β-cyclodextrin	3.7 (+32.1)	5.87 (+41.6)
LSD _{0.1%}	0.478	0.855

On comparing various sources of enzymes MARSHALL (1975) found that the β-amylase of batata (i.e. a higher plant) was more susceptible to inhibition by cyclodextrins than that of *Bacillus polymixa*.

In the germination of seeds an important role is played by the control that enzymes exercise on nutrient mobilization. It thus seemed obvious that, due to their inhibitory effect on amylase, the enzyme responsible for the decomposition of starch, cyclodextrins could be used for germination control in wheat seeds.

The cause of the stimulation exercised by cyclodextrin treatment on post-germinative growth and development, resulting in an ultimate increase in yield, is not yet clear. Reference can be made to the analogy observed with growth regulators of the "retardant" type (CATHEY 1964), when initial growth inhibition is followed by a favourable trend in the generative processes, secondary plant substances (chlorophyll, etc.). As regards the cyclodextrins, observations of this nature are only available from the present experiments; nothing of this kind has been reported in the literature so far.

The "antigibberellin" or "antimetabolite" character attributed to the effect of retardants is generally traced back to competitive interactions, and the selective influence on the growing tip is considered to be essential to the retarding effect. It may be assumed that the permanence of the effect of cyclodextrin seed treatment (that influences the plant in the initial stages of growth) must also be related to an influence on the growth sites (growing tip). The results of electron microscopic studies and examinations of protein and nucleic acid syntheses, which are now in progress, will supply more detailed information on these questions.

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RESULTS OF RESISTANCE BREEDING IN ALFALFA II. RESISTANCE TO VERTICILLIUM WILT

The efficiency of alfalfa production is greatly influenced by the lifespan of the stand. A stand providing fodder of sufficient quantity and quality in the third or even fourth year is a precondition for economical production.

In Hungary the thinning of the alfalfa stand begins by the end of the second year, depending on the variety, particularly in the case of intensive harvesting. Thinning is caused mainly by *Fusarium*, and to a lesser extent by *Verticillium* wilt.

Szökő (1966) was the first author in Hungary to demonstrate that in Transdanubia wilting and destruction in second and third year stands were caused by *Verticillium albo-atrum*. According to his observations, yield losses caused by this fungus species on highly infected areas may be as much as 30–40%.

In connection with studies on the possibility of breeding alfalfa for resistance, Bőjtös *et al.* (1969) chose 40 clones from a total of 700 during six years of preselection; the clones chosen proved to be suitable for producing basic material resistant to *Fusarium* and *Verticillium* wilt. At the same time, by inoculating seedlings, 10 plants resistant to *Verticillium* wilt were selected. STEUCKARDT *et al.* (1971) tested a number of west and East European varieties and strains against *Verticillium albo-atrum* and found the Hungarian alfalfa varieties and strains to be highly susceptible. The degree of infection for all Hungarian varieties was over 4.

Although the damage done by *Verticillium* in Hungary is at present less serious than in the countries north and west of Hungary, breeders must nevertheless endeavour to increase the *Verticillium* resistance of the varieties in order to avoid losses caused by this pathogen and for the purposes of seed export.

The occurrence of *Verticillium albo-atrum* and the assessment of the damage it causes have been dealt with by many foreign researchers: AUBÉ—SACKSTON (1964) in Canada, KUDELA—MALIK (1974) in Czechoslovakia, STEUCKARDT *et al.* (1971) in the German Democratic Republic, NIELSEN—ANDREASEN (1970) in Denmark, ZALESKI (1957), ISAAC (1957), CARR (1960), HEALE—ISAAC (1963) and AUBURY—ROGERS (1969) in England, GONDRAN (1976, 1977) in France, PANELLA *et al.* (1969) in Italy, PANTON (1964) and LUNDIN (1969) in Sweden, and GRAHAM *et al.* (1977) in the United States of America. PANTON (1965) found the selection of plants with a high resistance level to be an efficient method of resistance breeding. Later (PANTON 1967) he demonstrated that, though its genetic background had not yet been clarified, resistance seemed to be controlled by a multigenic system with an additive or multiplicative effect. NIELSEN—ANDREASEN (1975) produced alfalfa with a high level of resistance from a susceptible variety through repeated selection over four generations. By repeated recurrent selection STEUCKARDT *et al.* (1971) lowered the degree of infection from over 4 in the initial stock to below 3 in most tested plants.

In the current experiments an effort was made to increase the level of resistance to *Verticillium* in the varieties commercially produced at present.

The experiment was carried out with two Hungarian-bred alfalfa varieties: Tápió-szelei-1, a variety state registered in 1970, a synthesized selection of French, American, Soviet and Hungarian local varieties; and Szarvasi-2, a variety registered in 1978, produced by the synthesis of strains developed from Hungarian local varieties showing resistance in the field.

Selection for *Verticillium* resistance was made in two cycles for each variety. Inoculation was performed three times during the first selection cycle, and twice during the second cycle in the stock used as the basis of evaluation. The degree of infection was established after the second inoculation in each cycle, since the third inoculation in the first cycle took place immediately before transplanting, so the third inoculation of the second cycle is not yet available for evaluation. Thus, the resistance level attained after the second inoculation in the second cycle was the result of a total of five inoculations in two cycles.

The pure culture required for the inoculation was isolated from plants collected from alfalfa fields in southeastern Hungary. The fungus was propagated in an Erlenmeyer flask on a grain mixture of wheat and oats. The suspension required for the inoculation was prepared in the following way: the contents of the flask were mixed in a shaker after the addition of water, then the remains of the grains were removed from the pulp thus obtained by filtering.

After adding further water the concentration of the suspension was adjusted to 22 million spores/ml.

The seedlings were raised as described for the production of *Fusarium* resistant basic stock (BAKHEIT - TÓTH 1979).

The first inoculation was carried out in both cycles when the roots of the germ plants were 2 cm long. The tips of the roots were immersed in the suspension and cut, so that the spores and conidia were pressed into the roots. Then the plants were placed in a plastic dish containing 550 g Danube sand mixed with 80 ml fungus suspension.

The inoculated seedlings were raised at a temperature of 19–21°C and a relative humidity first of 95 then of 85%. The tested plants were placed in categories according to the degree of infection (Fig. 1):

- 1 = healthy, symptom-free
- 2 = traces of infection
- 3 = moderate infection, clearly visible symptoms
- 4 = strong infection, conspicuously weak plants
- 5 = destroyed plants

The degree of infection was calculated by the formula presented earlier (BAKHEIT—TÓTH 1979).

Plants placed in the first and second categories when evaluated a month after the first inoculation were used for the second inoculation. The roots of these plants were washed clean in water, then after the removal of the root tips the plants were placed in a suspension for 24 hours, then planted into propagation boxes each containing 10 kg soil mixed with 500 ml fungus suspension. Seven weeks after transplantation the inoculated plants were re-evaluated according to the extent of wilting. Plants placed in the first and second categories were inoculated again, then planted out. In the field trial the plants were tested again, then resistant plants were selected again from the treated and control plots of each variety and these were intercrossed by variety and treatment. Pollination was carried out by wild bees put under the isolators. The seed thus obtained was used as basic stock in the next cycle. In the second cycle all the procedures were the same as those described for the first cycle.

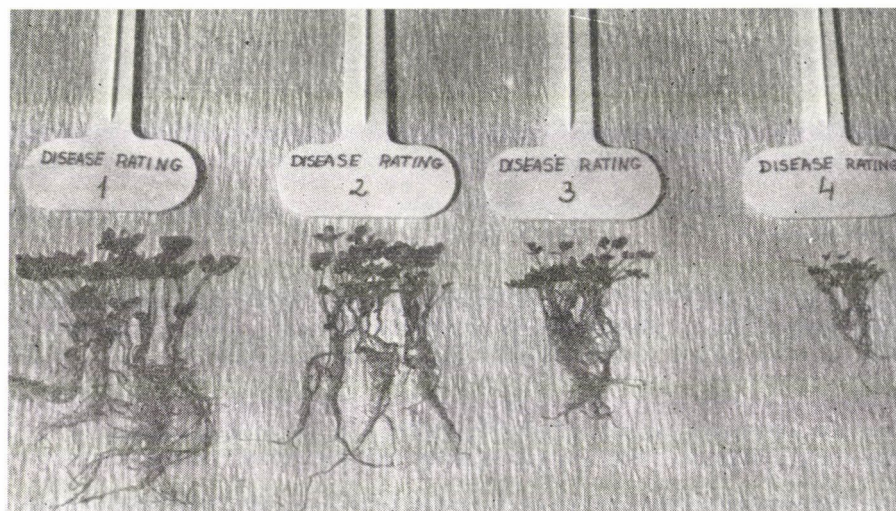


Fig. 1. Grading of plants by the degree of infection

Table 1

Wilt reaction of control plants and plants tested with Verticillium albo-atrum in the first cycle

Variety	Treatment	Relative distribution of plants in the wilting categories					Degree of infection	Number of tested plants
		1	2	3	4	5		
I. One month after the first inoculation								
Szarvasi-2	inoculated	12.50	41.73	21.47	3.90	20.40	2.780	3000
Szarvasi-2	control	68.84	14.50	3.83	3.50	9.33	1.700	600
LSD 5%							0.141	
LSD 1%							0.190	
Tápiószelei-1	inoculated	18.80	40.67	17.10	4.03	19.40	2.646	3000
Tápiószelei-1	control	64.83	16.50	5.00	4.00	9.67	1.772	600
LSD 5%							0.141	
LSD 1%							0.190	
II. Seven weeks after the second inoculation								
Szarvasi-2	inoculated	18.14	20.04	22.81	11.99	27.02	3.097	1474
Szarvasi-2	control	74.18	10.02	4.06	1.86	9.88	1.632	392
LSD 5%							0.626	
LSD 1%							0.851	
Tápiószelei-1	inoculated	25.04	30.56	18.27	7.36	18.77	2.644	1729
Tápiószelei-1	control	72.86	14.02	3.72	1.55	7.85	1.575	208
LSD 5%							0.722	
LSD 1%							0.982	

1 = Healthy plants; 2, 3, 4 = plants with symptoms of infection; 5 = destroyed plants.
Resistant plants = categories 1 and 2

The degree of infection for the control and for plants inoculated twice in the first cycle, and the relative number of plants belonging to the different wilting categories are shown in Table 1. Table 2 gives the corresponding data for the second selection cycle. The data in the Table reveal that the number of plants belonging to the first (healthy) category was smaller in the inoculated treatments than in the control. On the other hand, in categories 2, 3, 4 (plants with symptoms of infection) and 5 (destroyed plants) the inoculated plants are in the majority. There was a significant difference in the degree of infection between inoculated and control plants, although the difference was less in the second cycle on both occasions of testing than in the first cycle (Fig. 2).

In the initial stock of the variety Szarvasi-2 the degree of infection was 2.78 in the inoculated treatment and 1.7 in the control after the first testing, and 3.097 and 1.632, respectively, after the second testing. In the variety Tápiószelei-1 the corresponding values were 2.646 and 1.772 after the first, and 2.644 and 1.575 after the second testing, respectively.

Table 2

Wilting reaction of control plants and plants tested with Verticillium albo-atrum in the second cycle

Variety	Treatment	Relative distribution of plants in the wilting categories					Degree of infection	Number of tested plants
		1	2	3	4	5		
I. One month after the first inoculation								
Szarvasi-2	inoculated	64.22	11.22	9.00	3.56	12.00	1.879	1800
Szarvasi-2	control	92.33	2.33	1.33	0.33	3.67	1.210	300
LSD 5%							0.337	
LSD 1%							0.459	
Tápiószelei-1	inoculated	62.67	9.67	8.67	3.55	15.44	1.994	1800
Tápiószelei-1	control	91.80	1.40	1.20	0.20	5.40	1.260	500
LSD 5%							0.282	
LSD 1%							0.384	
II. Seven weeks after the second inoculation								
Szarvasi-2	inoculated	77.05	6.48	4.19	3.52	8.76	1.605	825
Szarvasi-2	control	95.82	2.13	0.50	0.00	1.55	1.093	192
LSD 5%							0.260	
LSD 1%							0.360	
Tápiószelei-1	inoculated	76.72	7.05	5.22	3.76	7.25	1.578	957
Tápiószelei-1	control	98.66	0.67	0.00	0.00	0.67	1.034	165
LSD 5%							0.255	
LSD 1%							0.353	

1 = Healthy plants, 2, 3, 4 = plants with symptoms of infection, 5 = destroyed plants.
Resistant plants = categories 1 and 2

The data summarized in Table 3 show that a comparison of the two selection cycles reveals significant differences not only in the degree of infection but also in the number of resistant plants, the number of plants with symptoms of infection and the number of destroyed plants on all occasions of testing in both varieties (Table 3). In the variety Szarvasi-2 the ratio of resistant plants, those with symptoms and destroyed plants after the second testing was 38.18, 54.83 and 27% in the first cycle, and 83.53, 14.19 and 8.76% in the second cycle, respectively. In the variety Tápiószelei-1 the ratio of resistant plants was 55.6%, that of plants with symptoms of infection 56.19%, and that of destroyed plants 18.77% after the second testing in the first cycle. In the second cycle the corresponding values were 83.76, 16.04 and 7.25%, respectively.

The frequency of resistant plants obtained by inoculating five times in two selection cycles was calculated from the data of Tables 1 and 2. The results show that the frequency of resistant plants in the variety Szarvasi-2 was 20.7% after the second inoculation in the first

Table 3

Effect of selection on the level of resistance to Verticillium in the alfalfa varieties examined

Variety	Treatment	Selection cycle	Degree of infection	Resistance	Healthy	With symptoms	Destroyed
			%				
Szarvasi-2	first inoculation	first	2.780	54.23	12.50	67.10	20.40
		second	1.879	75.44	64.22	23.78	12.06
		LSD 5%	0.200	6.96	5.44	5.52	24.80
		LSD 1%	0.265	9.25	7.23	7.34	6.372
Szarvasi-2	second inoculation	first	3.097	38.18	18.14	54.84	27.02
		second	1.605	83.53	77.05	14.19	8.76
		LSD 5%	0.264	9.23	7.22	7.32	6.36
		LSD 1%	0.351	12.26	9.59	9.73	8.40
Tápiószelei-1	first inoculation	first	2.646	59.47	18.80	61.80	19.44
		second	1.994	72.34	62.67	21.89	15.40
		LSD 5%	0.200	6.96	5.44	5.52	4.87
		LSD 1%	0.265	9.25	7.23	7.34	6.37
Tápiószelei-1	second inoculation	first	2.644	55.60	25.04	56.19	18.77
		second	1.578	83.76	76.72	16.04	7.25
		LSD 5%	0.244	8.51	6.66	6.75	5.87
		LSD 1%	0.324	11.31	8.84	8.97	7.79

cycle, and this rose to 63.02% after the second inoculation in the second cycle. In the variety Tápiószelei-1 the frequency of resistant plants was found to increase from 33.07 to 60.6%.

The results of the experiments show that the two varieties examined are less susceptible to *Verticillium* than to *Fusarium*, but the development of resistance to the former is a slower process. The results confirm the statement that resistance to *Verticillium* is controlled by a system of several genes, including one or more with an additive effect (PANTON 1965).

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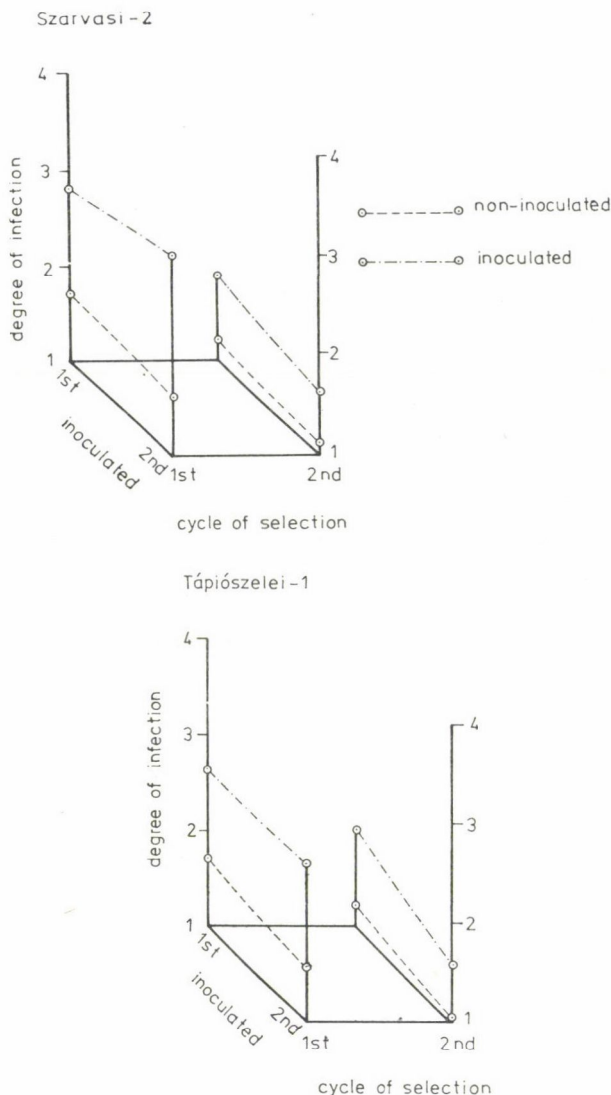


Fig. 2. Degree of infection in inoculated and control plants in the two selection cycles

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EFFECTS OF MAIZE SILAGE AND ALFALFA HAY ON NUTRITIONAL BEHAVIOUR AND MILK PRODUCTION OF DAIRY COWS

Under Hungarian conditions the winter diet of cows is based mainly on maize silage and alfalfa hay with a supplement of grain. It is known that the yield of silage maize is large compared with that of other roughage crops. In addition, silage maize is easier to preserve, while alfalfa is rather difficult to ensile. The technology of hay making, storage and rationing represents a problem for the farms. It is thus reasonable to include as much maize silage as possible in the diet of cows, or even to supply it as the only roughage fed. On these grounds, earlier investigations were aimed at replacing hay fully or partially by maize silage, and the studies were primarily concerned with its effect on milk production as the most important economic factor. The results, however, are far from being unequivocal.

The differences in views concerning the question are clearly reflected by the data presented in foreign and Hungarian literature. According to some authors, although maize silage fed with moderate rations of grain ensures satisfactory milk production, the latter can still be increased by feeding supplementary hay. WAUGH *et al.* (1955) and HOLTER *et al.* (1973) think it reasonable to supplement the silage-based diets of cows with hay, mainly because it increases the fat content of the milk. Yet, in their opinion, feeding maize silage as the only roughage is also possible. According to Soviet authors (BURDELEV *et al.* 1970), maize silage fed for a long time as the only roughage is not advisable at or above a milking level of 4000 kg;

green feed in summer and hay in winter must not be omitted from the diets of dairy cows, otherwise the production will decrease. In an experiment carried out by WALDERN (1972) supplemental hay increased the volume of milk production compared to singly fed silage, irrespective of the dry matter content of the silage consumed. Feeding maize silage as a single roughage, the author found that the body weight of cows increased while their persistence worsened. A similar phenomenon was observed by ALLO (1970). VÉRITÉ—JOURNET (1975) found in their experiment that maize silages harvested at various stages of ripening were poor feeds from the point of view of milk production, and that the persistence of the cows was low. Primarily with a view to covering the energy and protein requirements and ensuring their proper ratio, they consider it necessary to include hay, particularly alfalfa hay, in the diets of cows. Referring to the results of investigations in France, TEVELI (1976) gives an account of a decrease in milk production and weight gain and an increase in butterfat content (but without any change in the volatile fatty acid composition of the rumen juices) when feeding cows on maize silage rations with identical energy levels as a single roughage. The aim is thus to increase the proportion of roughage in the feed rations of dairy cows as much as possible.

There are authors, on the other hand, who do not consider the addition of hay to maize silage to be favourable for milk production. BELYEA *et al.* (1975) composed three kinds of feed rations for dairy cows: 1. maize silage *ad libitum*, 2. maize silage rationed plus alfalfa haylage or 3. alfalfa hay fed *ad libitum*. No significant differences were found in the milk production of the cows. THOMAS *et al.* (1970) fed either maize silage or alfalfa hay as single roughage over three lactation periods. Cows in the silage group produced similar volumes of milk to those consuming hay, and no difference was found when the amount of milk was adjusted to 4% butterfat content (FCM) either. Nor was the persistence of the cows affected by the different kinds of basic feed.

TRIMBERGER *et al.* (1972) studied the effect of liberal feed consumption on energy utilization by cows and found that different types of roughage had no significant influence on the digestibility of the energy. Accordingly, there is little justification for approaching the question from the point of view of the digestibility of nutrients. Fewer publications have appeared on the behavioural aspects of the subject. The data in the relevant literature mostly contain generalities, mentioning the daily periods and distribution of behaviour patterns, and the relation of these to the quality of the feed. In this field the investigations made by CZAKÓ (1974) can be taken as a basis. This author found that under stanchion barn conditions, similar to those in the present studies, dairy cows spent 14–20% of the day eating roughage and 30% ruminating. BÁRCZY—CZAKÓ (1962) call attention to the fact that the daily period of feed consumption by cows is determined primarily by the composition of the feed ration, while the daily rhythm of activity depends on the order of work. Studying the relationship between feed quality and rumination, PORZIG (1969) points out that the poorer the quality of feed the longer the period of rumination. According to the investigations of GELLING *et al.* (1958), when silage is self-fed, more cows eat in the first hour after milking than at any other time of the day. The number of cows eating is the lowest immediately before milking. The average time spent daily in silage consumption was found to be three and a half hours, with extreme values of 1 hour 25 minutes and 5 hours 10 minutes.

The daily periodicity of behavioural characteristics was also noticed in the course of earlier observations on dairy cows and pregnant heifers (SZÜCS—MOLNÁR 1975). The preliminary results of the investigations were reported at the 28th annual meeting of the European Association of Animal Production (SZÜCS *et al.* 1977).

No other publications concerning the effects of silage and alfalfa hay as singly fed roughages on the behaviour patterns of cows have been found in either the Hungarian or the foreign literature.

Table 1
Feeding plan

Phases		Groups		
Designation	Length (day)	I (n = 10)	II (n = 10)	III (n = 10)
		Roughage rations fed*		
Preliminary phase	7	Roughage rations usual in the farm		
Adjustment phase	7	A	B	C
1st experimental phase	28	(hay)	(hay + silage)	(silage)
Adjustment phase	7	C	B	A
2nd experimental phase	28	(silage)	(hay + silage)	(hay)
Post-experimental phase	7	Roughage rations usual in the farm		

* A = alfalfa hay

B = alfalfa hay + maize silage at a ratio of 1 : 1 on a dry matter basis

C = maize silage

The rations were balanced by the addition of grain mixtures with different starch equivalent, crude protein and mineral contents and were thus sufficient for maintenance and the production of 20 kg milk a day. Percentage composition of grain mixtures fed in the rations marked A, B and C:

	A	B	C
maize meal	96.0	75.0	46.0
extracted sunflower meal	—	21.0	22.0
extracted soya meal	—	—	11.5
wheat bran	—	—	11.3
wheat meal	—	—	3.8
mineral supplement	4.0	4.0	4.6

In the experiment set up to study the questions raised, the change-over design shown in Table 1 was used. In the experiment three groups of 10 cows in their second lactation, producing nearly the same daily amount of milk, were included. The animals were in the first third of the lactation period. The balanced rations sufficient for maintenance and the production of 20 kg milk a day were composed in such a way that the differences in nutritive value due to the varying roughages were compensated by changing the composition of the supplemental grain mixtures. It was thus hoped to ensure identical supplies of dry matter, starch equivalent, digestible crude protein, minerals and raw fibre for the animals in all three treatments of both experimental phases. The rations were measured out and fed twice a day.

The grain was rationed individually and the roughage by groups. The maize silage in the C ration was given gradually to increase the consumption. The amount left over was measured back before the next feeding. Samples were taken from the feedstuffs fed once in each of the adjustment phases and twice in each of the experimental phases, and were sent for analysis to the Special Service Station for State Farms in Szolnok county. The same was done with the feed left over and measured back. Milk was weighed individually at each milking. At the end of the first and second experimental phases individual ethograms were prepared by means of observations every 5 minutes over 48 hours. The results of the experiment are summed up in Table 2.

Feed and nutrient consumption. The first two weeks of the experiment practically coincided with the change-over of the whole dairy farm to winter feeding, so the feed and

Table 2

Average daily feed and nutrient consumption, daily milk production and feed conversion in the different phases of the experiment

	Groups					
	I (n = 10)		II (n = 10)		III (n = 10)	
	experimental phases					
	1st	2nd	1st	2nd	1st	2nd
<i>Feed consumption, kg dry matter</i>						
Total	16.73	15.79	16.43	16.53	15.65	16.70
Consisting of						
alfalfa hay	9.92	—	4.96	5.04	—	10.08
maize silage	—	10.00	4.95	4.99	9.87	—
grain mixture A	6.81	—	—	—	—	6.62
B	—	—	6.52	6.50	—	—
C	—	5.79	—	—	5.78	—
<i>Nutrient uptake, kg</i>						
Starch equivalent	9.43	9.61	9.45	9.48	9.60	9.24
Digestible crude protein	1.982	1.714	1.844	1.852	1.707	1.986
Ca	0.143	0.089	0.117	0.118	0.088	0.145
P	0.089	0.083	0.083	0.084	0.082	0.088
<i>Nutrient concentration of daily rations consumed, %</i>						
Starch equivalent concentration	55.8	60.9	54.0	57.4	61.4	55.3
Protein concentration	19.9	16.8	18.3	18.4	16.7	20.2
Raw fibre in dry matter	19.2	19.2	18.5	19.8	19.6	19.6
<i>Daily average milk production, kg</i>						
\bar{x}	14.98 ^a	12.50 ^b	16.64	14.64	16.74	16.34 ^c
s ^o / _o	6.68	9.52	24.64	21.93	21.09	22.09
<i>Daily milk production relative to the preliminary phase, %</i>						
\bar{x}	100.4 ^d	83.9 ^e	102.9 ^f	90.9 ^g	98.3	96.3 ^h
	3.9	9.5	5.7	7.2	18.0	20.7
<i>Nutrient utilization with maintenance proportion included</i>						
kg starch equivalent/kg milk production	0.623	0.769	0.568	0.648	0.574	0.566
kg digestible crude protein/kg milk production	0.132	0.137	0.111	0.127	0.102	0.122

a—b; d—e; f—g: P < 0.1%; b—c: P < 1%; e—g; e—h: P < 5%

Table 2, continued

Average nutrient contents in feedstuffs fed

Feedstuff	Dry matter, %	Composition on absolute dry matter content basis, g/kg			
		starch equivalent	digestible crude protein	Ca	P
Alfalfa hay	84.1	357	135	13.2	3.9
Maize silage	25.1	524	40	7.2	3.2
Grain mixture A	89.2	851	95	1.8	7.3
B	89.5	780	150	2.4	8.9
C	88.3	767	227	3.0	8.8

(The fermentation of the silage was good, pH = 3.9; the quality of the alfalfa hay was better than medium.)

nutrient supply of the experimental animals varied almost every day. In the adjustment phase the experimental rations were gradually introduced, making modifications every two days. The appetite of the cows, which rose when they got used to the different feeds, was satisfied by giving increased rations.

The average daily dry matter consumption exceeded the planned amount. The daily dry matter consumption of cows fed on alfalfa hay as the only roughage was higher than that of cows consuming silage. The average dry matter consumption of cows fed on a mixture of alfalfa hay and silage was intermediate. The daily amounts of starch equivalent, digestible crude protein and mineral consumption also exceeded those envisaged. Only with the rations containing maize silage did it prove impossible to fully cover the daily calcium requirements. Observations show that, as in earlier experiments, milk production did not fully reflect the nutrient supply in the present experiment either.

The starch equivalent concentration of the feed rations was lower in diets based on alfalfa hay than in those containing silage. The protein concentration showed the opposite tendency. The nutrient concentration of diets containing both roughages gave an intermediate value. The raw fibre supply was satisfactory in all three treatments.

The Ca : P ratio of the feed rations for cows consuming both hay and silage in both phases of group II of the experiment was close to 1.1 : 1, a ratio at present considered to be optimum. When alfalfa was the singly fed roughage this ratio was higher, while when feeding silage by itself it was lower, particularly in the first phase of group III. Apart from this exception the macro-element supply was satisfactory.

Milk production. The absolute values of daily average milk production and its relative values, expressed as percentages of the preliminary phases, were compared by groups (I, II and III) and phases. On comparing the first phases of the groups for the absolute average values of milk production no significant differences were found ($P > 5\%$). In the second experimental phase, on the other hand, cows in group I (silage-based diet) and group III (alfalfa-based diet) showed significant differences concerning the daily milk production ($P < 1\%$).

When the individual phases within the groups were compared for the average value of daily milk production the difference between the first (hay diet) and second (silage diet) phase in group I proved significant ($P < 0.1\%$). Between the average of the first and second phase in group II, when the cows were fed on diets containing both alfalfa hay and silage, no statistical differences were found ($P > 5\%$). The situation was similar when comparing the first (silage diet) and second phase (hay diet) in group III.

In order to screen the effect of differences in milk production at the beginning of the experiment, no matter how slight they were, the milk production was analysed in comparison

to the preliminary phases as well. Differences between the first phases of groups I, II and III did not prove significant in any of the cases. When comparing the average values of the second phase significant differences were found between group I (silage diet) and group II (silage + hay) as well as between group I (silage diet) and group III (hay diet) ($P < 5\%$), while the difference between group II (silage + hay) and group III (hay diet) was non-significant ($P > 5\%$). When comparing the first and second phases within the groups a highly significant difference ($P < 0.1\%$) was found in the case of group I when changing over from feeding hay to the silage-based diet. For the cows in group II which consumed both alfalfa hay and silage throughout the experiment, the difference between the first and second phase in milk production relative to the preliminary phase was also highly significant ($P < 0.1\%$). In group III the average values of relative milk production in the first (silage diet) and second (hay diet) phase did not significantly differ ($P > 5\%$). In spite of the sometimes high relative coefficients of variation for the average values the differences observed can be regarded as systematic effects.

The average trend of milk production during the experiment is shown in Fig. 1. As seen from the Figure the milk production of all three groups varied greatly in the preliminary and adjustment phases, due partly to changes in the diet and partly to other disturbing effects (change of place). The sharp reduction in milk production during the first phase of group III (silage-based diet) was the consequence of a change in the person charged with the care of the animals

The data lead to the conclusion that a change-over from alfalfa hay to maize silage results in a reduction in the milk production. A change-over from maize silage to alfalfa hay, on the other hand, proved to be favourable for the daily volume of milk production. The daily milk yield of cows consuming both silage and hay decreased gradually during the two successive experimental phases.

Feed conversion. The starch equivalent used for the production of a unit amount of milk during the second phase increased in groups I and II, and decreased in group III compared to the first phase of the experiment. The amount of digestible crude protein used for the production of 1 litre of milk showed no significant change in group I and slightly increased in groups II and III. The data seem to suggest that the reduction in milk production in this experiment was partly due to differences in the amount of protein supplied with the three diets. Changes in the level of starch equivalent seem to have had less influence on milk production, though no far-reaching conclusions can be drawn in this respect.

The behaviour of the cows. The trends of behaviour characteristics and their biometric evaluation are contained in Table 3, while the daily distribution of behaviour patterns is shown in Figs 2a, b and c. No essential differences in the daily period and distribution of lying down were observed, either between the groups or between the experimental phases within the groups.

The time spent each day in consuming the daily rations in the maize silage-based diet was much longer than when feeding rations based on alfalfa hay. A comparison of the first and second phases within the groups, or of the groups within the experimental phases, confirms this statement. It thus seems that feeding diets composed of various roughages but with the same dry matter and raw fibre contents modifies the time of eating. A similar phenomenon was observed when analysing the process of rumination.

When evaluating the daily distribution of the nutritional behaviour data it is found that maize silage prolongates the time of eating and rumination compared to alfalfa hay. In the case of two-component diets (hay + silage) it is the maize silage that determines the time spent eating and ruminating. According to TóTH (1977) this can be explained by the large amount of volatile fatty acid which enters the rumen with the silage and from there into the blood circulation, thus influencing the sensation of hunger in the animal and the

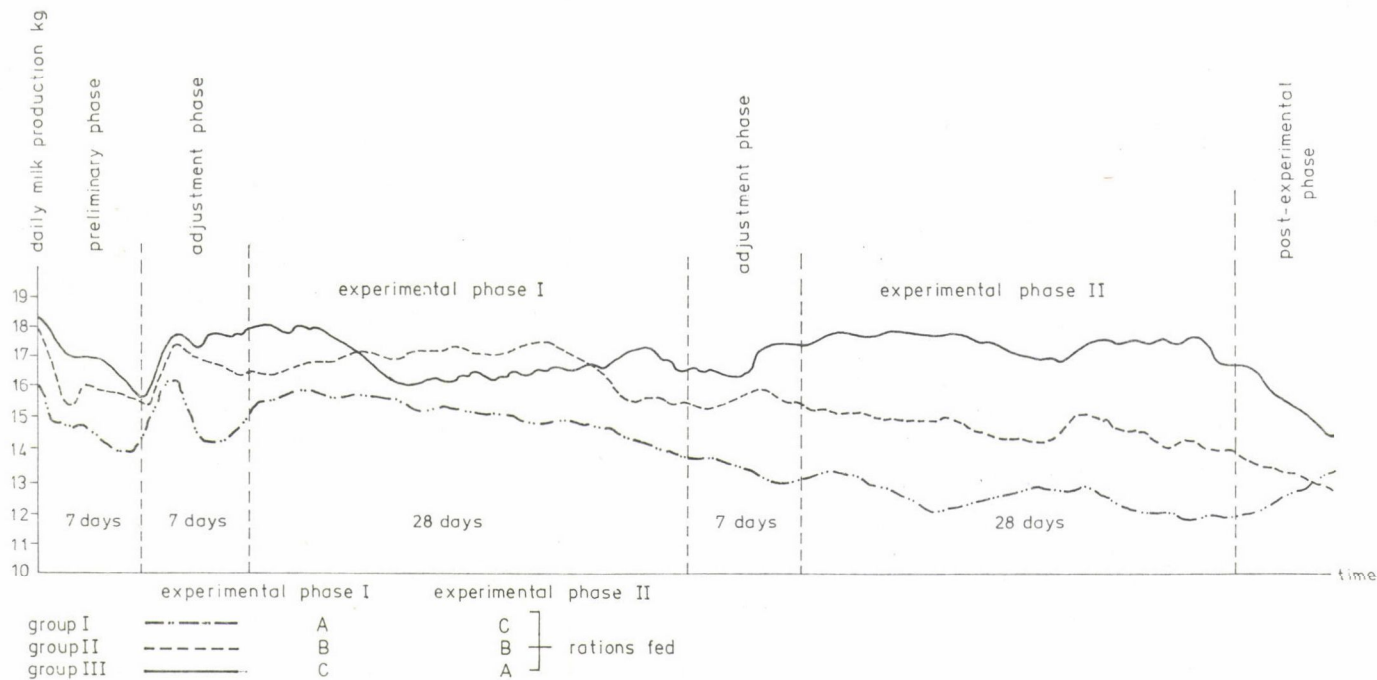


Fig. 1. Trend of daily average milk production in the experiment

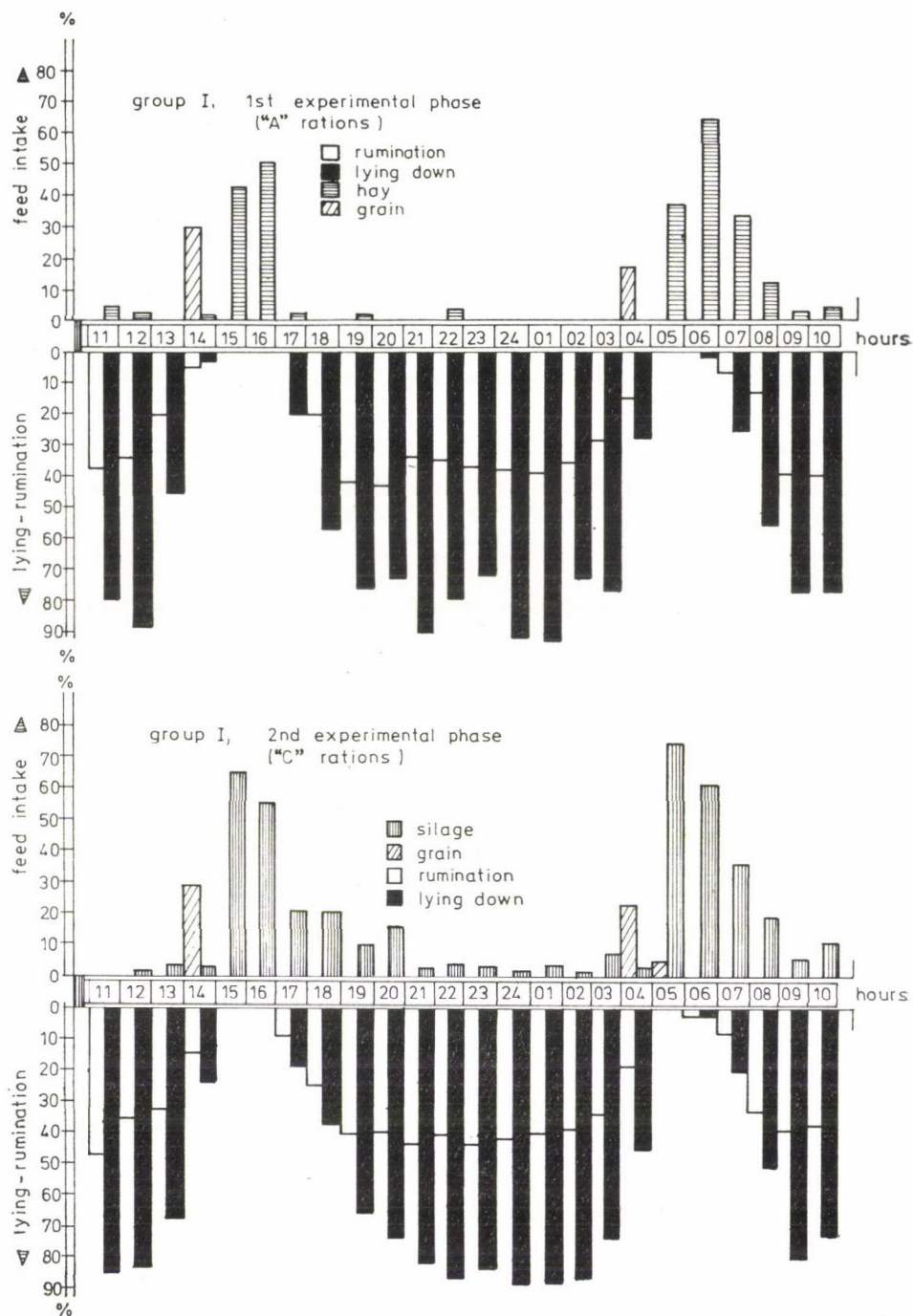


Fig. 2. Daily distribution of behaviour responses

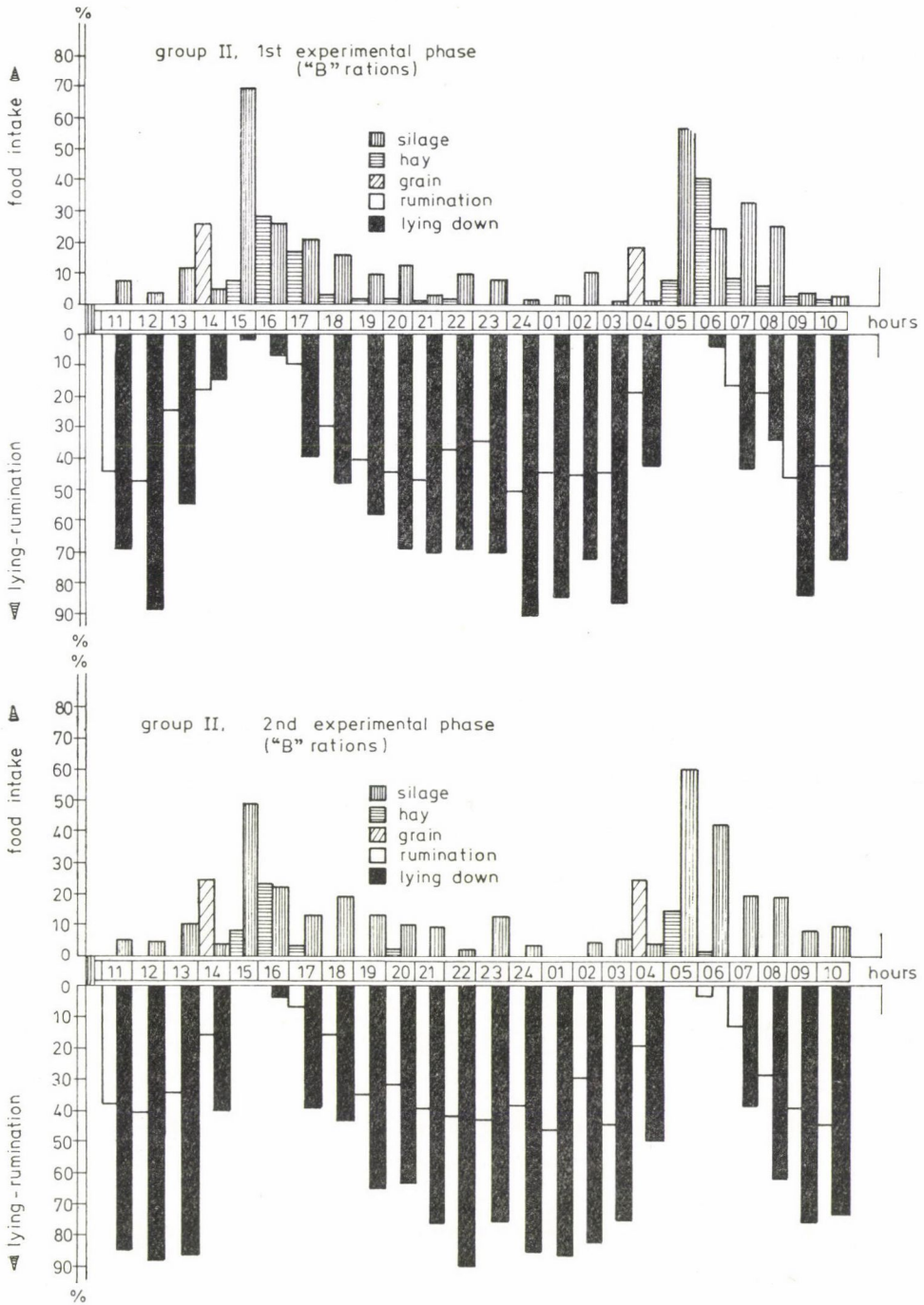


Fig. 2. (cont'd)

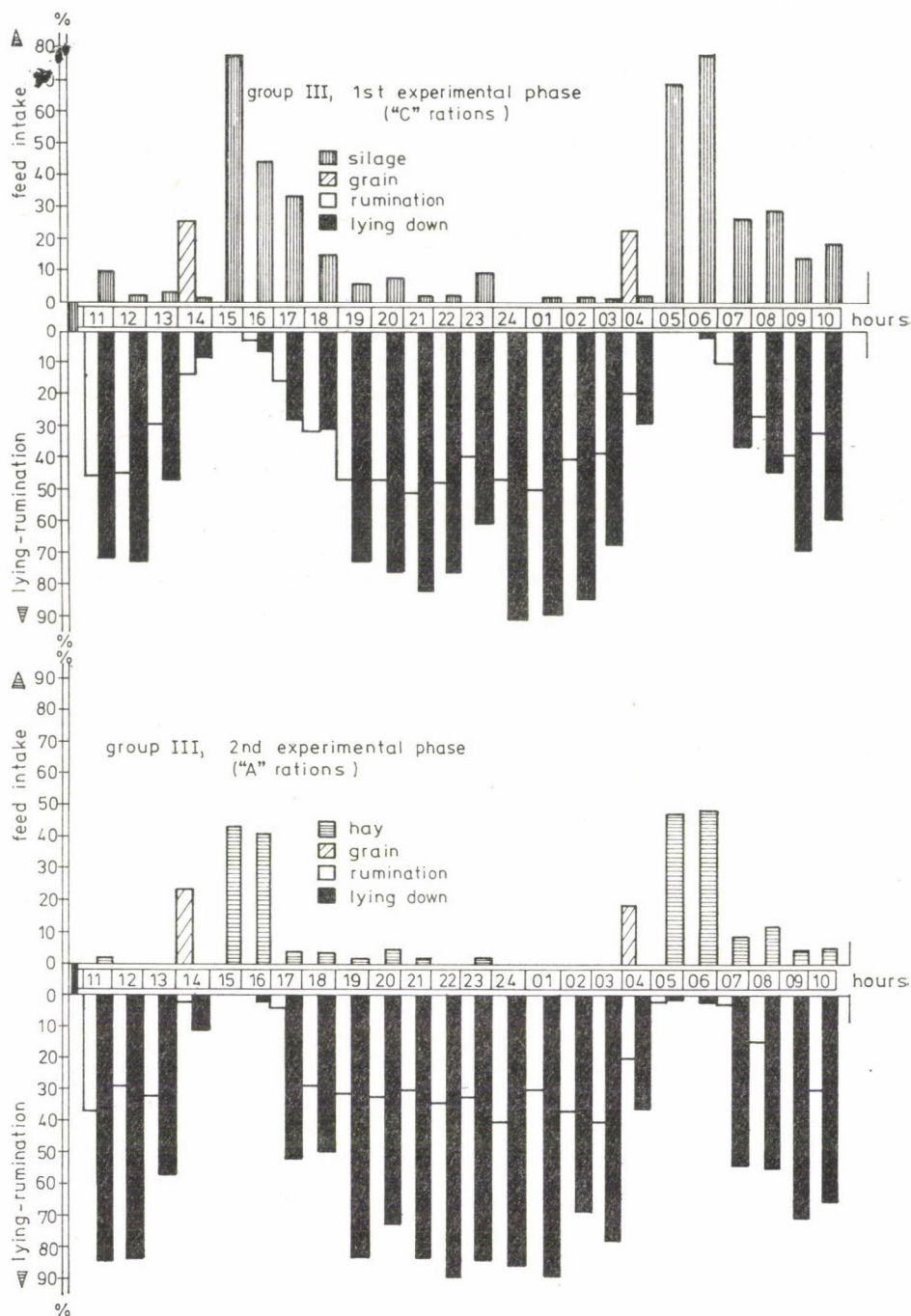


Fig. 2. (cont'd)

Table 3

Percentage trend of daily behaviour responses during 48-hour periods of observation

	Groups					
	I (n = 10)		II (n = 10)		III (n = 10)	
	experimental phases					
	1st	2nd	1st	2nd	1st	2nd
Lying down \bar{x}	54.8	56.6	54.1	58.0	50.7	57.7
s ^o / _o	10.3	7.4	14.5	15.4	14.0	16.5
Feed intake \bar{x}	13.5 ^a	20.1 ^b	22.8 ^c	19.9 ^d	21.7 ^c	12.8 ^f
s ^o / _o	10.2	16.9	16.5	15.0	9.1	13.0
Rumination \bar{x}	24.2 ^g	28.7 ^h	29.8 ⁱ	26.9 ^j	30.7 ^k	22.6 ^l
s ^o / _o	6.0	11.3	11.9	10.6	8.4	17.9

a—b; e—f; a—c; a—e; b—f; d—f; g—h; k—l; g—i; g—k: $P < 0.1\%$; c—d; h—l: $P < 1\%$;
i—j; j—l: $P < 5\%$

mechanism controlling eating. As stated by BÁRCZY—CZAKÓ (1962), the daily rhythm of animal behaviour is determined primarily by the order of work done in the shed, i.e. by the feeding time. The daily resting time of the animals is divided into a shorter daytime and a longer night period. The time of rumination shows a similar distribution.

All in all, it can be established that of the two kinds of roughage of basic importance in Hungary, alfalfa hay and maize silage, the former is more favourable for milk production in cows. Nevertheless, the feeding of maize silage to cows cannot be abandoned, because maize has favourable yield and fermentation properties, and is important with respect to area management and nutrient economy. As a consequence of feeding maize silage the periods of eating and rumination become longer compared to those observed in the case of the alfalfa hay-based diet. When feeding two-component rations the time of eating and rumination is determined primarily by the silage.

Although these data cannot be used in practice directly, the research results obtained may nevertheless provide a basis for further investigations aimed at studying the effects of the quantity of hay and quality of silage to be fed.

*

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MORPHOMETRY OF MONOLAYER TISSUE CULTURES II

I. Introduction

A map prepared from the basic density data of monolayer tissue cultures is sufficient in itself to supply a large amount of useful information (ALDRIDGE—PYE 1976, OTHMER—ALDRIDGE 1978). An analysis of the surroundings discloses the signal channels which conduct information from the medial pixel to the underdeveloped neighbours or from the more developed neighbours to the medial pixel. Pixels with a developmental level equal to that of their neighbours are "ambivalent pixels" and indicate the critical points of connection (FEHÉR 1979, FIFE 1976, GÁNTI 1978, GIERER—MEINHARDT 1972, GREGUSS 1974). An analysis of the relative potential (NEMES-NAGY *et al.* 1982) ensures the comparability of cultures of different ages.

None of these procedures, however, yields direct numerical information on the trophic supply of the individual pixels. The present paper describes a method for determining the nutrient supply and nutrient deprivation levels of the individual pixels.

A topologically adequate method of mapping and selection disclosed higher levels of correlation between the pixels.

1.1. Material and methods

The basic data map for 17 density category codes obtained with Opton-Microvideomat I and calculated through discrimination to the cytoskeleton was again taken as the point of departure (NEMES-NAGY *et al.* 1982).

2.1. Data processing

Only pixels with a complete set of 8 nearest neighbours were considered. The sum of the density codes of the 8 surrounding (circular) pixels was called the circular index (C), as shown below.

a)	b)	c)
1 1 1	1 2 3	17 17 17
1 1 1	8 9 4	17 17 17
1 1 1	7 6 5	17 17 17
C = 8	C = 36	C = 136

With the help of the circular index (C) the surroundings value (S_i) relative to M (medial pixel) can be given as $S_i = \frac{8 M}{C}$.

The potential value is obtained by multiplying the density code of the medial pixel with the circular index:

$$P = M \cdot C$$

Transformation of data to obtain a measure of supraindividual organisation

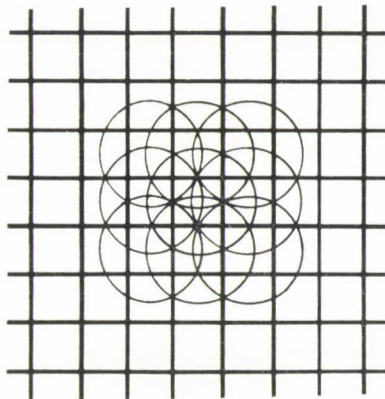


Fig. 1. Through overlapping and intermingling of the circular indices an arabesque-like pattern is formed. The second distance lattice forms a system of 5×5 pixels. In this system pixel M is represented 8 times. The ninth ring is formed by the 8 joint pixels surrounding pixel M, i.e. the circular index of M

Let us calculate the quotient $\frac{P}{S}$

$$\frac{P}{S} = \frac{\frac{M C}{8 M}}{\frac{C}{8 M}} = \frac{M C^2}{8 M} = \frac{C^2}{8}$$

Thus for $\frac{P}{S}$ the "individual" M is invariant, and $\frac{P}{S}$ represents a measure of supra-individual organisation (JUHÁSZ-NAGY—VIDA 1978).

Topologically adequate texture analysis and selection system (TATASS).

2.1.1. Overlaps of circular indices

Any pixel M (save the marginal ones) has 8 nearest neighbour pixels. This unit is called the first distance lattice. In the second distance lattice pixels M has its own circular index and is simultaneously an element of 8 overlapping circular indices. Of the latter four are diagonal and four orthogonal. There are two left-inclined and two right-inclined diagonal overlaps and upper, lower, right and left orthogonal overlaps (Figs 2/a I, 2/b I).

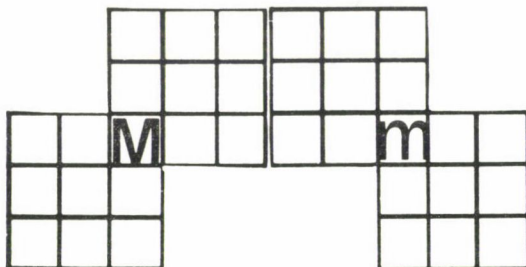


Fig. 2/a I. The second distance lattice can be divided into 2×2 diagonals, on the left side into the left compartments, on the right side into the right compartments (M and m , respectively, being the common overlapping members). After topological readjustment complete overlappings appear

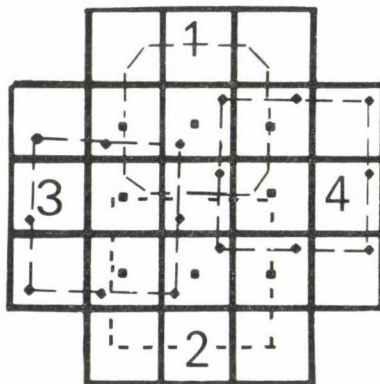


Fig. 2/b I. The orthogonal appearance of the second distance lattice produces vertical (1, 2) and horizontal (3, 4) rings

The introduction of the second distance lattice makes it possible to draw a number of interesting conclusions:

1. From the gradational differences between the diagonal and orthogonal circular indices of the second distance lattice a combined, higher level value for the flow is obtained (territorial flow). An analysis of territorial flow cannot replace the pixel flow analysis, but it is more suitable for judging wider regional characteristics and tendencies.

2. For pixel M the diagonals of the second distance lattice give a full marginal line ("outer defence ring") (Fig. 2/a II).

3. The orthogonals of the second distance lattice form the internal defence ring (Fig. 2/b II).

4. The diagonals are unable to sense a "descent" attack behind the marginal line. However, they keep the functions of the whole marginal line under control (Fig. 3).

5. The orthogonals are unable to sense attacks against the territory angles, while they fully control the internal defence ring. The orthogonals determine the regeneration of the internal defence ring. The orthogonal analysis discloses the weak points of the defence system against toxic, etc. noxa arising from pixel contact, as well as from the fluid phase of the culture (Figs 2/b I, 2/b II).

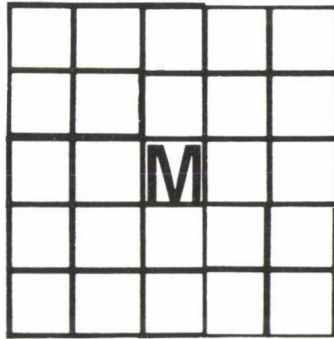


Fig. 2/a II. Through topological adjustment the rings overlap each other and m will be under M. The marginal line of the second distance lattice becomes complete

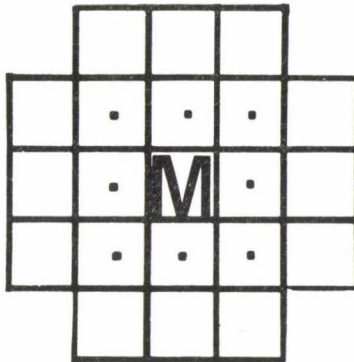


Fig. 2/b II. The orthogonals of the second distance lattice form the inner defence ring around pixel M. The 4 vertex pixels of the marginal line do not fall under the control of the orthogonal system

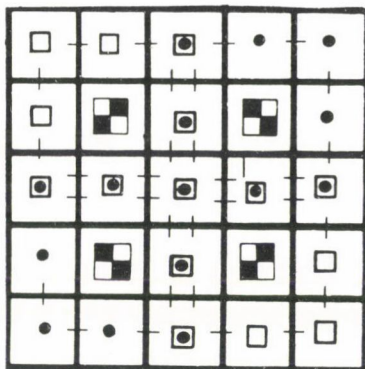


Fig. 3. The complex orthogonal and diagonal system of the second distance lattice. The four inner pixels not controlled by the diagonal rings are symbolised by a chess-board pattern

6. For the toxic noxa two kinds of favourable directions are available.

In the inner ring this is along the lowest gradient of the four diagonals.

In the outer ring this is along the lowest gradient of the four orthogonals.

7. The circular indices actually represent a circular territorial sum.

8. The relative value of pixel M in the first distance lattice can be written in the form

of a fraction $\frac{M}{C}$. M, however, is only one factor of C in 8 second distance lattices.

9. The scanning of the basic density data was performed with a $25\times$ objective, while the second distance lattice only corresponds to the magnification of a $3.2\times$ objective. Nonetheless it retains the resolution of the $25\times$ objective, i.e. density data.

2.1.2. Map of supraindividual organisation

The map constructed from the $\frac{C^2}{8}$ values of the pixels expresses the local nutrient demand of the culture. In this context the qualitative characterisation of the surroundings is useful. A pixel more developed than the surroundings = active pixel; one less developed than its surroundings = passive pixel; pixels and surroundings equally developed = ambivalent pixels. Such maps do not resemble the potential map and have a different meaning as well (Figs 4/a, b).

2.1.3. Column and row analysis of maps

The maps are fitted into a quadrangular lattice; thus, they may be analysed as columns or rows. Minimum-maximum values and ambivalent pixels are traced sequentially along the X or Y axes. This yields "stripes" of trophic activity, the trophic demand contrast appearing along the stripes. The percentage distribution of active, passive and ambivalent pixels calculated from the trophic map reflects the trophic demand system of the examined compartment of the culture (Figs 4/b I, b II).

With the aid of a plastic second distance lattice screen placed over the trophic map the fundamental regional, territorial structure can be disclosed.

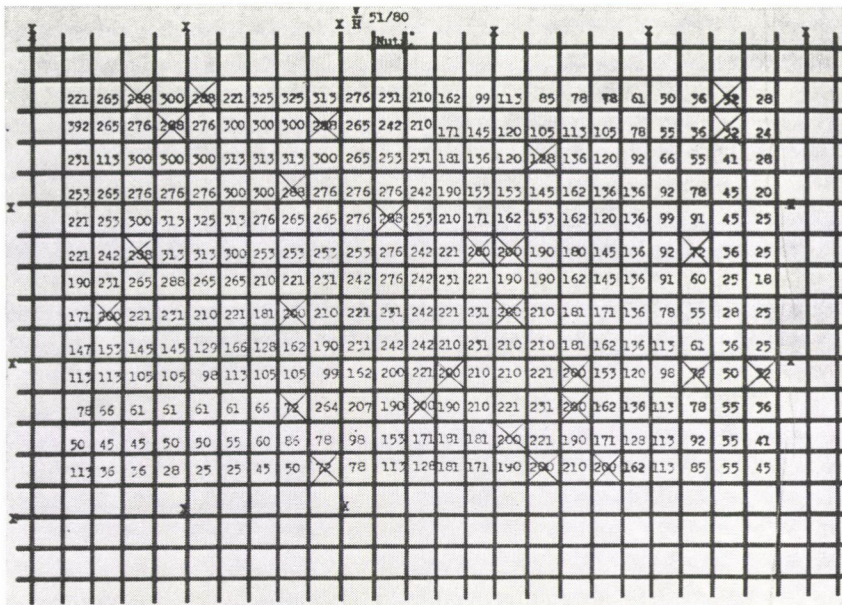


Fig. 4/a 51/80. Nutrition analysis map. The ambivalent pixels are marked X

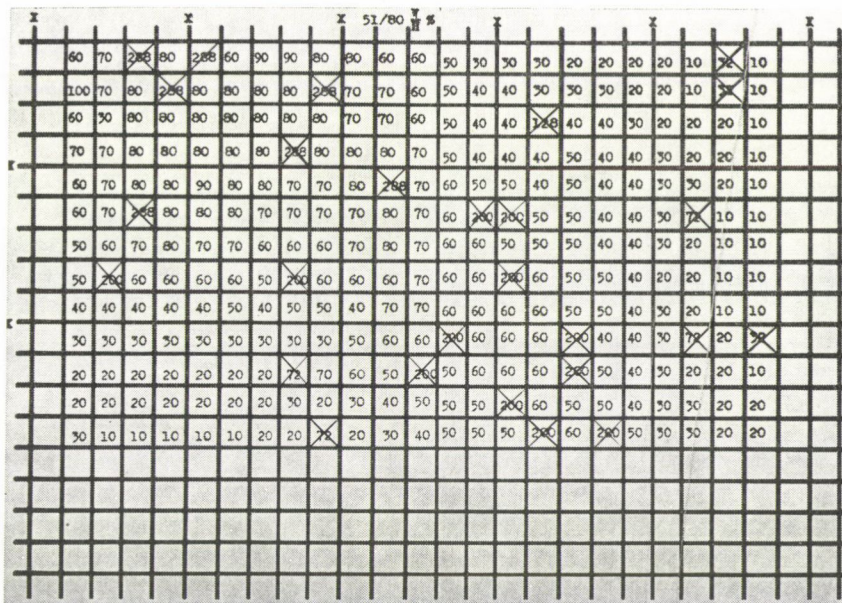


Fig. 4/b 51/80. Relative nutrition analysis map. The values of ambivalent pixels are present as "absolute" data. 39.2 = 10%; 78.4 = 20%; 117.6 = 30%; 156.8 = 40%; 196.1 = 50%; 235.3 = 60%; 274.5 = 70%; 313.7 = 80%; 352.9 = 90%; 392.1 = 100%

2.1.4. Idealised and real conditions

Under idealised conditions it is enough to take the surrounding pixels into consideration. Under real conditions there is always a layer of culture fluid and a layer of substrate present. Thus, 9 culture-fluid pixels also have to be considered, existing above pixel M and its 8 neighbour pixels, i.e. a total of 9 top layer pixels. Therefore, $\frac{P'}{S'} = \frac{C^2}{w \cdot 17}$, where w is a medium-dependent factor.

Using the same reasoning to consider also the substrate (nine bottom layer pixels) we have $\frac{P''}{S''} = \frac{C^2}{w' \cdot 26}$, where w' is a substrate-dependent factor.

It follows that the system of $\frac{C^2}{8}$, $\frac{C^2}{w \cdot 17}$, $\frac{C^2}{w' \cdot 26}$ ensures a selection as regards to cellular, medium and substrate environment. It discloses the trophic processes, demands and possibilities.

Since $\frac{C^2}{8}$, $\frac{C^2}{17}$ and $\frac{C^2}{26}$ functions essentially represent a $C \cdot k_i$ function, it is clear that it is the actual value of C that determines the shape of function k_i .

The lowest and highest values of C are 8 and 136, respectively. The functions $\frac{C^2}{8}$ and $\frac{C^2}{17}$, when solved for all possible values of C , yield only two common integers, i.e. at $C = 68$ and $C = 136$. With both of these functions $C = 68$ represents the median and $C = 136$ the end point of the full series of possible values. No common integer is obtained at any value of C with the function $\frac{C^2}{26}$.

2.1.5. The inverse functions

For a complete analysis of the system it seems useful to evaluate not only the direct but also the inverse functions as listed below.

A) Surroundings analysis

$$S_i = \frac{8 M}{C}$$

Inverse surroundings analysis (dependence analysis)

$$\frac{1}{S_i} = \frac{C}{8 M}$$

B) Potential analysis

$$P = M \cdot C$$

Inverse potential analysis

$$\frac{1}{P} = \frac{1}{C \cdot M}$$

C) Nutrition analysis

$$N = \frac{P}{S} = \frac{C^2}{8}$$

Inverse nutrition (deprivation) analysis

$$\frac{1}{N} = \frac{S}{P} = \frac{8}{C^2}$$

$\left(\frac{C^2}{17}, \frac{C^2}{26} \right.$ and their inverses, if they are needed, in the above sense.)

Inverse surroundings analysis (A)

If $S_{inv} > 1.01$, we speak of the environment helping or "nursing" pixel M.

If $S_{inv} = 1.0$ the situation is ambivalent (as it is when $S_i = 1.0$).

If $S_{inv} < 1.0$ pixel M is "exploited" by its surroundings. Examples:

a)	b)	c)	d)
2 2 2	3 3 3	11 11 11	17 17 17
2 1 2	3 1 3	11 1 11	17 1 17
2 2 2	3 3 3	11 11 11	17 17 17
C = 16	C = 24	C = 88	C = 136
$S_{inv} = 2.0$	$S_{inv} = 3.0$	$S_{inv} = 11.0$	$S_{inv} = 17.0$

Due to the absolute value of the C ring, the "nursing" shows an increasing tendency.

e)	
3 3 3	C = 24
3 3 3	$S_{inv} = 1.0$
3 3 3	The situation is ambivalent.

f)	g)	h)
1 1 1	9 9 9	16 16 16
1 17 1	9 17 9	16 17 16
1 1 1	9 9 9	16 16 16
C = 8	C = 72	C = 128
$S_{inv} = 0.0588$	$S_{inv} = 0.53$	$S_{inv} = 0.94$

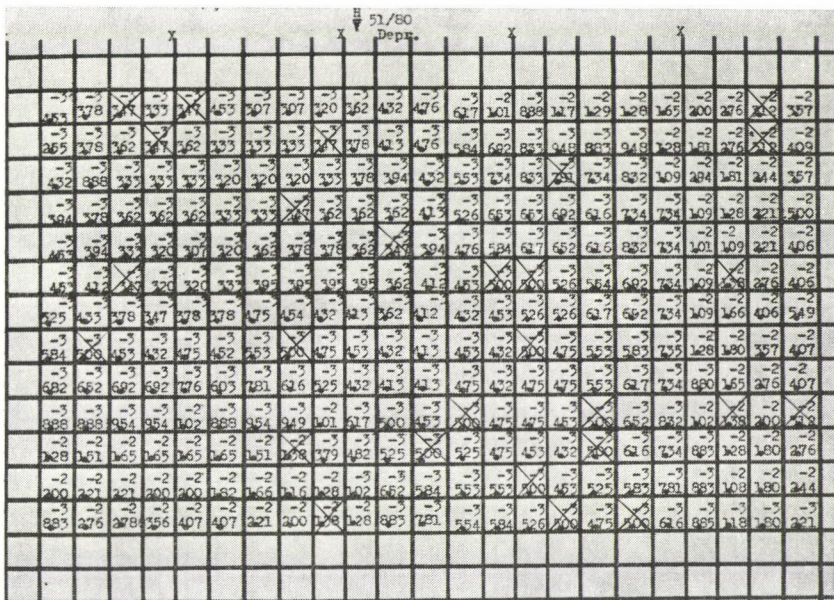


Fig. 5. 51/80. Deprivation analysis map. Pixels showing values of ambivalence are marked X

Due to the increasing tendency of the C ring values, the "exploitation" of pixel M shows a decreasing tendency.

Inverse potential analysis (B)

At the present phase of our work P_{inv} does not seem to be of any practical importance.

Inverse nutrition (deprivation) analysis (C)

If it is only the nearest neighbours which are depriving the central pixel, only the first distance lattice has to be considered, i.e. $\frac{8}{C^2}$.

If only the medium is depriving the underlying pixel M, $\frac{17}{C^2}$ is used.

If both the medium and the substrate are depriving pixel M, we have $\frac{26}{C^2}$.

$\frac{34}{C^2}$ indicates the full deprivation of pixel M by its complete surroundings.

It should be stressed that even full deprivation does not mean isolation (Fig. 5).

The deprivation analysis is also closely connected with the second distance lattice, as only the latter takes pixel M into account as an individual. The performance, condition and future of the individual pixel can only be assessed from the second distance lattice, which may tell us something about expansion, regression and retardation.

The study of this problem is now in progress.

3. Discussion

Even density maps show that untreated cultures have a sophisticated texture (ARSHAVSKII *et al.* 1965, BRYANT *et al.* 1977, BURDMAN—GOLDSTEIN 1964, DESCHEREVSKY 1973, GERISCH *et al.* 1975).

An evaluation of nutrition-deprivation is able to disclose the possibilities, directions and inner restrictions of development. These factors act in different ways even in two identical untreated normal cultures (minimum — maximum — realistic microfilament production). Cultures started at different points of time but fixed after the same period of existence give different standard deviation values (groups of temporal deviation).

Among the untreated cultures started at the same time some were quite different from their contemporaries while they strikingly resembled cultures started 3 months earlier (ata-vistic deviation).

The examination of parallel control cultures sometimes revealed new, so far unobserved variants (neoformative deviation). For the time being no explanation can be given for this phenomenon.

As a sensitive system, the tissue culture serves as a simple model for studies on deviant behavioural forms appearing in biological systems, and is also suitable for visualising the deviation. Therefore, a large number of data are needed to establish the reference values for a given type of culture (i.e. the basic rules characterising its topology). By means of a mathematical analysis of the monolayer pixel lattice several levels of organisation can be established for a culture. To this end morphological analysis alone is inadequate.

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VARIA II

TYPES OF DOMINANCE OF FRUIT CHARACTERISTICS IN VARIOUS F_1 HYBRIDS IN WATERMELON, *CITRULLUS LANATUS* THUNB

As a result of the wide use of F_1 seed in vegetables, it is important to study the F_1 hybrids in watermelon for commercial production as one of the most popular summer crops. Fruit characteristics were used in this investigation. The F_1 plants resulting from a cross between specific parents, produced fruits having special features related to those of the parents. This study also deals with the inherited pattern of fruit characteristics and its possible use as a genetic marker in watermelon breeding.

The genetic behaviour of fruit characteristics was reported by WEETMAN (1973), POOLE—GRIMBALL (1945), FILOV—TOSCEV (1968), SUZUKI—HALL (1971), NANDPURI *et al.* (1974) and ALLAM (1976).

Eight cultivars, namely, Shipper, Congo, Sugar Baby, Short-Internode, Giza 1, Kaho, Yellow Skin and Leeby, were used in this investigation at the Vegetable Crop Research Station at Giza, Faculty of Agriculture, Cairo University, from 1972 to 1977. These cultivars were introduced from the U.S.A. and Japan, except for Short-Internode, Yellow Skin and Leeby, which originated in Egypt and were described by ABD EL-HAFEZ (1969) and ALLAM (1976). Also, Giza 1 is the standard local cultivar. All these cultivars were selfed for several generations before crossing. Forty-three straight and reciprocal crosses were made between the eight cultivars to obtain F_1 hybrids.

The fruit characteristics of the parents and F_1 hybrids were recorded for each fruit of the different populations. The weight of the fruit was measured in kg, and the fruit diameter and length in cm. The shape index of the fruit is the ratio of diameter/length $\times 1000$. The rind thickness was expressed in cm. The percentage of total soluble solids was determined using a hand refractometer.

Analysis of variance was carried out and the degree of dominance of the character expressed in the F_1 hybrid was determined according to POWERS' procedure (1945).

The types of dominance for the fruit characteristics are shown in Tables 1, 2, 3 and 4.

1. *Fruit weight.* On the basis of the results obtained for all crosses with various male and female parents, the weight of the fruit in three populations (P_1 , P_2 and F_1) was highly significant in 36 crosses.

As to the degree of dominance of this character as shown in the F_1 , the data indicate a positive heterosis beyond the heavy parent in three crosses, and complete and partial dominance of heavy weight over light weight in eleven and two crosses, respectively. An absence of dominance was evident in 14 crosses. On the other hand, negative heterosis below the light parent was encountered in one cross, and complete and partial dominance of light over heavy weight in three and two crosses, respectively.

The tendency of this character was towards the heavy parent where it reached 45% in relation to 17% to the light parent. It is worth noting that the F_1 fruit weight tended towards the male parent in 45% of the crosses (the same percentage as that tending towards the heavy parent) and 17% behaved like the seed parent.

In general, 9% of the crosses were heavier than the heavy parent, 39% were intermediate, 36% resembled the pollen parent, 14% the seed parent and 3% were below the male parent. The hybrids which showed heterosis were from the parent Giza 1. Crosses of heavy \times light parents gave lower fruit weight than the reciprocals. Thus, it is better to use the heavy weight as the paternal parent.

2. *Fruit diameter.* Results on the diameter of the fruit in all crosses between various parents, indicate that the parents and F_1 differed in all crosses, except for 10 hybrids having cultivars of similar diameter.

As to the degree of dominance judged from the character of the F_1 fruit, the data indicate that the broad diameter was completely or partially dominant over the narrow diameter. This type of dominance was found in nine and three crosses, respectively. A positive heterosis was evident in the cross between Short-Internode and Giza 1. Dominance was complete for narrow over broad diameter in four crosses. A negative heterosis was recorded in the cross between Congo and Shipper. An absence of dominance was encountered in fifteen crosses.

Thus, the resultant F_1 hybrid would significantly deviate in fruit diameter towards the broad parent (39%) and its value can be seen in crosses showing absence of dominance (45%); i.e. the fruit diameter of F_1 would be intermediate between that of the two parents.

This character tended towards the male parent in 33% of the crosses and towards the female parent in 21%. In general, 3% were broader than the broader parent, 45% were intermediate, 30% were similar to the male parent, 18% to the female parent and 3% were below both.

3. *Fruit length.* It appears that 37 of the 43 crosses used to study the genetic behaviour of fruit length and male and female parents with different fruit lengths. The longest fruit was that of the parent Congo followed by Shipper and Kaho, then by Leebby, Giza 1, Sugar Baby and Short-Internode, and finally by Yellow Skin which had the shortest length.

The type of dominance of this character varied according to the parents involved in the crosses. There was a positive heterosis beyond the long fruit in four crosses, complete and partial dominance of long over short fruit in fifteen and one cross, respectively, and complete and partial dominance of short over long fruit in one cross each, while absence of dominance was evident in fifteen crosses.

Obviously, the tendency of this character was towards the long fruit. The F_1 fruit may be longer (11%), as long or almost as long as the long parent (44%), or intermediate in length between the two parents (in 41% of the crosses).

Fruit length tended towards the male parent in 32% of the crosses and to the female parent in 26%. On the other hand, 10% of the crosses exceeded the long parent, 27% resembled the pollen parent and 21% the seed parent.

4. *Fruit shape index.* In regard to the fruit shape index, there was a highly significant difference between the various populations in 19 of the 43 crosses. The Congo and Kaho cultivars had a lower shape index than the remaining parents.

The fruit shape index of the resulting F_1 hybrids showed complete dominance of the low index over the high index in four crosses (21%). An absence of dominance was evident in fifteen crosses (79%). In other words, the F_1 resulting from three crosses would produce fruit of low shape; i.e. elongated or semi-elongated.

The tendency of this character was to the medium shape in most crosses and to the female parent in rare crosses. As a result of this, low shape \times high shape index produces F_1 fruit of low shape, while the reciprocal cross produces medium shape.

5. *Rind thickness.* On the basis of all the data available on rind thickness, there was a highly significant difference in thickness between the populations of all the crosses tested, except for eleven crosses.

The rind thickness of the F_1 plant showed a complete dominance of thick rind over thin in eight crosses, a positive heterosis in three crosses, and a partial dominance in one cross. Absence of dominance was encountered in twelve crosses. The reverse type of dominance, i.e. thin over thick rind, was complete in five crosses, positive in two crosses and partial in one cross. Thus, the resultant F_1 hybrid would significantly deviate in rind thickness towards the thick rind in 37% of the crosses, show absence of dominance in 38% of the crosses and tend to the thin rind in 25% of the crosses.

This character tended towards the female parent in 40% of the crosses and towards the male parent in 22%. 9% of the crosses exceeded the thick parent, 28% were similar to the seed parent, 19% to the pollen parent and 6% were below the seed parent; 30% were intermediate.

6. *Total soluble solids.* Data for all crosses studied for total soluble solids indicate a significant difference in the soluble solids between the different populations in 35 out of 43 crosses.

The low percentage of total soluble solids was completely dominant over the high percentage in thirteen crosses. Negative heterosis below the low percentage was evident in one cross. Absence of dominance was found in ten crosses. On the other hand, the dominance of the high percentage over the low was encountered in seven crosses. Positive heterosis beyond the high percentage was recorded in four crosses.

Thus, the F_1 plant had a tendency to give fruit with a low percentage of total soluble solids in 40% of the crosses and a high percentage in 31% of the crosses.

Table 1

Type of dominance in every cross for various fruit characteristics in watermelon

No.	Crosses	Fruit					
		weight	diameter	length	shape index	rind thickness	total soluble solids
1	Shipper × Congo	—	—	AD	AD	—	—
2	Congo × Shipper	NH	NH	AD	CDS	NH	—
3	Shipper × Sugar Baby	AD	AD	CDL	—	CDS	CDS
4	Sugar Baby × Shipper	AD	AD	AD	—	CDS	AD
5	Shipper × Short-Internode	CDS	CDS	AD	—	CDL	—
6	Short-Internode × Shipper	CDL	CDL	CDL	—	CDS	PH
7	Shipper × Giza 1	AD	CDS	AD	—	CDL	AD
8	Giza 1 × Shipper	AD	AD	CDL	—	AD	CDS
9	Kaho × Shipper	PDL	AD	—	AD	AD	AD
10	Yellow Skin × Shipper	AD	AD	AD	—	AD	—
11	Leeby × Shipper	CDL	—	CDL	—	AD	CDS
12	Congo × Sugar Baby	CDS	CDS	AD	CDS	CDS	CDS
13	Sugar Baby × Congo	CDS	AD	PDS	AD	NH	AD
14	Congo × Short-Internode	AD	AD	PDL	CDS	—	CDL
15	Short-Internode × Congo	AD	CDS	AD	AD	—	—
16	Giza 1 × Congo	AD	AD	AD	AD	AD	AD
17	Congo × Kaho	PDS	AD	AD	—	AD	CDS
18	Kaho × Congo	PDL	PDL	CDL	—	PDL	AD
19	Yellow Skin × Congo	AD	AD	AD	AD	CDS	CDL
20	Congo × Leeby	PDS	—	AD	AD	—	CDS
21	Leeby × Congo	AD	—	AD	AD	—	CDS
22	Sugar Baby × Short-Internode	—	—	—	—	—	CDL
23	Sugar Baby × Giza 1	PH	—	CDL	—	CDL	—
24	Sugar Baby × Kaho	AD	AD	AD	AD	AD	CDS
25	Yellow Skin × Sugar Baby	CDL	CDL	CDL	—	AD	CDL
26	Sugar Baby × Leeby	—	—	—	—	—	CDS
27	Leeby × Sugar Baby	—	—	—	—	—	CDS
28	Short-Internode × Giza 1	PH	PH	PH	—	CDL	PH
29	Giza 1 × Short-Internode	CDL	—	CDL	—	CDL	PH
30	Short-Internode × Kaho	CDL	CDL	CDL	AD	PDS	—
31	Yellow Skin × Short-Internode	—	—	—	—	AD	CDS
32	Short-Internode × Leeby	CDL	CDL	CDL	—	—	AD
33	Leeby × Short-Internode	AD	AD	CDL	—	—	AD

Table 1 continued

No.	Crosses	Fruit					
		weight	diameter	length	shape index	rind thickness	total soluble solids
34	Giza 1 × Kaho	CDL	CDL	CDL	AD	CDL	—
35	Giza 1 × Yellow Skin	PH	CDL	PH	—	PH	PH
36	Yellow Skin × Giza 1	CDL	AD	CDL	CDS	—	AD
37	Leeby × Giza 1	CDL	CDL	—	—	AD	CDS
38	Kaho × Yellow Skin	—	CDL	AD	AD	AD	NH
39	Yellow Skin × Kaho	—	AD	CDS	AD	AD	CDS
40	Kaho × Leeby	CDL	PDL	PH	AD	PH	CDL
41	Leeby × Kaho	AD	PDL	CDL	AD	CDL	AD
42	Yellow Skin × Leeby	CDL	CDL	PH	—	CDL	CDL
43	Leeby × Yellow Skin	AD	AD	CDL	—	PH	CDL

— No significant difference between the populations (P_1 , P_2 and F_1)

NH Negative heterosis, i.e. heterosis below the small parent

CDS Complete dominance towards the small parent

PDS Partial dominance towards the small parent

AD Absence of dominance, i.e. intermediate between the parents

PDL Partial dominance towards the large parent

CDL Complete dominance towards the large parent

PH Positive heterosis, i.e. heterosis beyond the large parent

Table 2

Types of dominance of various fruit characteristics as expressed in the F_1 derived from various crosses

Characters		Number and percentage of crosses showing the dominance types						
		NH	CDS	PDS	AD	PDL	CDL	PH
Fruit weight	No.	1	3	2	14	2	11	3
	%	3	8	6	39	6	31	8
Fruit diameter	No.	1	4		15	3	9	1
	%	3	12		45	9	27	3
Fruit length	No.		1	1	15	1	15	4
	%		3	3	41	3	41	11
Fruit shape index	No.		4		15			
	%		21		79			
Rind thickness	No.	2	5	1	12	1	8	3
	%	6	16	3	38	3	25	9
Total soluble solids	No.	1	13		10		7	4
	%	3	37		29		20	11

Table 3

Number and percentage of F_1 of various crosses showing the tendency of fruit characteristics toward the parents

Characters		Male				AD	Female				Total
		NH	CD*	PD+	PH		NH	CD*	PD+	PH	
Fruit weight	No.	1	9	4	2	14		5		1	36
	%	3	25	11	6	39		14		3	101
Fruit diameter	No.		8	2	1	15	1	5	1		33
	%		24	6	3	45	3	15	3		99
Fruit length	No.		10		2	15		6	2	2	37
	%		27		5	41		16	5	5	99
Fruit shape index	No.		1			15		3			19
	%		5			79		16			100
Rind thickness	No.		4	2	1	12	2	9		2	32
	%		13	6	3	38	6	28		6	100
Total soluble solids	No.	1	8		1	10		12		3	35
	%	3	23		3	29		34		9	101

CD* = CDL or CDS parent. PD+ = PDL or PDS parent

Total soluble solids tended towards the female parent in 43% of the crosses and towards the pollen parent in 29%. 12% of the crosses excelled the better parent, 29% were intermediate, 34% resembled the maternal parent, 23% the paternal parent and 3% were below the pollen parent.

From the above mentioned results in crosses where the three populations (P_1 , P_2 and F_1) differed in a given character, the type of dominance was determined (Table 1). There are seven types of degree of dominance according to POWERS (1945). None of the characters studied showed one type of dominance in all crosses in the F_1 . Two to seven types of dominance were encountered in each character (Table 2). These various dominance types resulted from the use of different parents. Thus, for a given character, each cross behaved similarly or differently when compared with other crosses.

There were some crosses in each character where absence of dominance was involved. The expression of absence of dominance would indicate the deviation of the F_1 from both parents. Heterosis and partial or complete dominance would signify deviation from one of the parents. Under these circumstances, the value of the genetic marker would be emphasized, especially when the tendency is towards the male parent. The example of characters showing this tendency would be fruit weight, diameter, length and shape index (Table 3).

The morphology of the fruit of the watermelon was not critically mentioned in the available literature on the effect of crossing in this plant species, but FILOV—TOSCEV (1968) were in accordance with the present results on total soluble solids, when they demonstrated that of 88 hybrids between 18 cultivars, 27 excelled the better parent, 31 were intermediate, eleven resembled the seed parent, twelve the pollen parent and seven were below both. Also, NANDPURI *et al.* (1974) found that among 32 hybrids derived from 20 watermelon cvs and selections, sixteen hybrids outyielded the mean yield of their parents. The highest yield and fruit number were obtained from Shipper \times Striped Klondike. Sugar Baby \times Verona had the highest total soluble solids content.

However, the studies reported in the present paper could nearly lead to a generalized genetic tendency for the expression of various characters in the F_1 if the absence of dominance were neglected. Fruit weight and diameter tended towards the large and the male parent in most crosses; fruit length tended towards the long parent and the percentage of

Table 4
Average of various fruit characteristics among parents and their F_1 derived from different crosses

No.	Parents and their F_1 hybrids	Fruit					
		weight, kg	diameter, cm	length, cm	shape index	rind thickness, cm	total soluble solids, %
	I. Parents:						
1	Shipper	6.755	21.4	24.8	961.4	1.2	8.3
2	Congo	7.814	21.0	36.8	570.5	1.1	8.4
3	Sugar Baby	3.695	18.1	20.8	872.3	1.0	10.3
4	Short-Internode	2.783	16.4	18.6	880.4	1.0	9.4
5	Giza 1	3.417	18.0	19.8	909.3	0.8	10.1
6	Kaho	1.689	10.4	24.2	429.9	0.6	9.7
7	Yellow Skin	2.472	15.7	16.2	970.2	0.8	7.8
8	Leeby	4.310	19.6	21.0	933.2	1.0	7.1
	II. F_1 hybrids:						
1	Shipper \times Congo	7.080	20.8	29.5	707.3	1.1	9.4
2	Congo \times Shipper	5.209	17.9	28.6	631.0	0.9	8.8
3	Shipper \times Sugar Baby	5.615	19.8	24.1	816.4	0.9	8.8
4	Sugar Baby \times Shipper	4.829	19.0	22.6	839.8	0.9	9.3
5	Shipper \times Short-Internode	3.610	16.2	20.2	798.8	1.2	8.3
6	Short-Internode \times Shipper	6.474	20.7	26.9	769.5	0.9	11.4
7	Shipper \times Giza 1	4.011	18.4	22.0	836.5	1.1	9.2
8	Giza 1 \times Shipper	4.887	19.4	23.8	814.5	1.0	7.5
9	Kaho \times Shipper	5.012	17.6	27.2	658.4	0.9	9.3
10	Yellow Skin \times Shipper	4.422	17.8	21.8	816.8	0.9	8.8
11	Leeby \times Shipper	6.805	21.4	24.6	875.9	1.1	7.0
12	Congo \times Sugar Baby	4.677	16.3	27.6	588.5	0.9	8.6
13	Sugar Baby \times Congo	4.601	18.8	25.8	729.9	0.8	9.2
14	Congo \times Short-Internode	5.603	18.2	31.0	594.6	1.0	10.0
15	Short-Internode \times Congo	4.317	16.8	25.6	656.5	1.0	8.8
16	Giza 1 \times Congo	5.522	19.0	27.8	686.6	0.9	9.4
17	Congo \times Kaho	3.210	14.2	30.4	475.1	0.9	8.4
18	Kaho \times Congo	5.410	17.2	37.0	469.3	1.0	9.4
19	Yellow Skin \times Congo	4.896	17.6	27.2	647.2	0.8	9.4
20	Congo \times Leeby	5.530	19.3	28.8	677.4	1.0	7.0
21	Leeby \times Congo	6.092	20.0	29.4	677.2	1.1	6.7
22	Sugar Baby \times Short-Internode	3.474	18.0	20.4	885.6	1.0	10.7
23	Sugar Baby \times Giza 1	4.852	18.7	23.3	807.8	1.0	9.2
24	Sugar Baby \times Kaho	2.738	13.6	23.0	593.4	0.8	8.6

Table 4 continued

No.	Parents and their F ₁ hybrids	Fruit					
		weight, kg	diameter, cm	length, cm	shape index	rind thickness, cm	total soluble solids, %
25	Yellow Skin × Sugar Baby	3.540	19.6	20.8	939.7	0.9	9.7
26	Sugar Baby × Leeby	4.594	19.8	22.7	878.2	1.0	7.4
27	Leeby × Sugar Baby	4.313	19.0	21.4	889.3	1.0	6.7
28	Short-Internode × Giza 1	4.935	20.0	23.3	857.6	1.0	11.8
29	Giza 1 × Short-Internode	3.926	17.6	22.0	800.8	1.0	11.6
30	Short-Internode × Kaho	3.707	15.2	26.0	590.4	0.7	8.8
31	Yellow Skin × Short-Internode	3.130	15.5	16.0	973.9	0.9	7.6
32	Short-Internode × Leeby	5.410	20.6	23.8	867.6	1.1	8.3
33	Leeby × Short-Internode	4.139	18.5	22.2	839.7	0.9	8.2
34	Giza 1 × Kaho	3.727	16.4	26.1	630.7	0.9	9.6
35	Giza 1 × Yellow Skin	4.683	19.8	23.6	841.7	1.0	11.3
36	Yellow Skin × Giza 1	4.008	17.4	22.4	779.3	0.9	9.0
37	Leeby × Giza 1	4.750	20.2	22.0	902.0	0.9	6.8
38	Kaho × Yellow Skin	2.363	14.8	21.4	691.9	0.7	6.0
39	Yellow Skin × Kaho	1.805	12.4	17.2	725.7	0.7	7.7
40	Kaho × Leeby	4.529	17.6	28.2	624.1	1.2	9.6
41	Leeby × Kaho	3.720	17.4	25.0	698.4	0.9	8.7
42	Yellow Skin × Leeby	5.164	20.8	24.6	845.5	1.0	8.8
43	Leeby × Yellow Skin	3.622	18.4	21.6	856.6	1.2	8.6
	L.S.D. (0.05%)	1.142	1.9	3.0	162.9	0.2	1.3

crosses tending towards the male and female parents was nearly equal, but the fruit shape index behaved essentially as a medium character and was intermediate between the parents. Rind thickness tended to the thick and female parent, while the tendency of total soluble solids was to the low percentage and the female parent.

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THE EFFECT OF WATER STRESS ON $N_2(C_2H_2)$ -FIXATION AND GROWTH OF *MEDICAGO SATIVA* L.

The effects of water stress on the growth and physiological activities of plants have been described in several reviews (KOZLOWSKI 1968, LEVITT 1972). From the array of literature cited, it is apparent that almost all physiological processes are adversely affected by water stress. The influence of soil moisture on symbiotic N_2 -fixation by nodules, however, seems to be a very neglected area of study. This process has received attention only recently and the effects of water stress on N_2 fixation have been demonstrated in a range of legumes including *Glycine max*, *Trifolium repens*, *Vicia faba* (SPRENT 1972a, b, ENGIN—SPRENT 1973, GALLACHER—SPRENT 1978) and *Pisum sativum* (MINCHIN—PATE 1975).

The rate of N_2 fixation by nodules of *T. repens* (ENGIN—SPRENT 1973) was shown to be considerably depressed by water stress. Water-stressed young soybean plants also showed a proportionate decline in the N_2 -fixing activity (KUO—BOERSEMA 1971, SPRENT 1972a, b). The C_2H_2 — C_2H_4 assay is now extensively used to estimate nitrogenase activity in nodules (HARDY *et al.* 1973) and recent studies have demonstrated that $N_2(C_2H_2)$ -fixation by *Vicia faba* (GALLACHER—SPRENT 1978) and three other species of legumes (FOULDS 1975b) was adversely affected by water stress. In addition to the effects on nodule activity, water supply modifies the nodule structure of *Glycine max* (PANKHURST—SPRENT 1975) and *Vigna unguiculata* (MINCHIN—SUMMERFIELD 1976).

Little work has been carried out on the species *Medicago*, particularly with respect to the effects of moisture stress on N_2 -fixation. FOULDS (1978b) reported that although *M. lupula* was able to survive in a droughted habitat, $N_2(C_2H_2)$ -fixation by this species was drastically reduced under drought conditions.

Because of its drought-resistant nature, *Medicago sativa* is used as a common fodder plant in areas subjected to mild and severe droughts. This has directed attention to the degree of adequacy of their symbiotic N_2 -fixing capacity under moisture stress. The present work was initiated to test the effect of deficient water supplies on growth and N_2 -fixation in *M. sativa* growing in pots but under the prevailing natural atmospheric conditions.

Growth of plants. In all the experiments, *Medicago sativa* var. *Arabian* was used. Surface sterilized seeds were germinated on wet filter paper in sterile Petri dishes. After 3—5 days, the seedlings were transplanted into 7-inch free-drainage clay pots. Each pot contained 2.4 kg of previously washed and sterilized sand. The seeds and the pots containing sand cultures were initially sterilized in order to eliminate contamination with inefficient *Rhizobium* strains that might have been present on the seed surface or in the sand, and also to eliminate the possible incidence of pathogenic bacteria and fungi.

Before transplanting in pots, the seedlings were inoculated with an effective strain of *Rhizobium meliloti* obtained from the Microbiology Research Centre, Ministry of Agriculture, Cairo. The *Rhizobium* cultures were grown and maintained on yeast extract mannitol agar. After the seedlings were inoculated and transplanted in pots, they were kept under natural non-sterile conditions.

The seedlings were transplanted to the pots on 20th November, 1977. During the period of plant growth, the mean temperature (of the winter season) was 22.2°C during the day and 8.3°C at night. Daylength varied from 10—11 1/2 hours.

After being transplanted to pots, the *Medicago* seedlings were re-inoculated with *Rhizobium* cultures in order to maintain a large number of bacteria in the rhizospheric sand and to obtain heavy nodulation of the roots. The plants were grown for 4—5 weeks, during

which time they were watered with a nutrient solution or alternatively with distilled water. The surface irrigation of the pots was made up to the field capacity level. This continued until the formation of a large number of healthy nodules was observed. Water stress treatments were imposed just after actively N_2 -fixing nodules had been formed.

Water treatments. The plants were subjected to four water regime treatments with 5 replicates for each treatment. Another set of reference pots was used for calculating the water content of the sand cultures during the experiments. The first of the four treatments was the control, where the pots were all watered with nutrient solution or distilled water to a constant weight. The water was never limited and there was free drainage. The actual weights used varied with plant age. The water content of these sand cultures was 12% of the sand dry weight. This treatment is symbolized as T_0 .

Stress. Three treatments were designed, T_1 in which watering was kept at 66% of the field capacity or approximately 8% water content, T_2 in which watering was designed to keep the sand cultures at 33% of the field capacity or 4% water content, and T_3 which had the least water content (2%) or only 16.5% of the field capacity. Reference pots were used to determine the incremental watering required for the treatments and their control replicates. The experimental pots were weighed daily and their water contents adjusted to the levels required.

Measurements of $N_2(C_2H_2)$ -fixation. The acetylene reduction assay (STEWART *et al.* 1967, HARDY *et al.* 1968) was used to estimate $N_2(C_2H_2)$ -fixation. Tests were carried out in 10 ml serum bottles with subseals. The plants were decapitated and whole roots of 2 plants were introduced into the serum bottles. C_2H_2 was injected to give a concentration of 10% (v/v) in the bottles, which were then incubated at 25°C for one hour only.

The detection of the ethylene produced was achieved on a 1.5 m \times 4 mm column of activated alumina, run at 150°C with 40 ml min⁻¹ of carrier N_2 in a Pye 104 gas chromatograph.

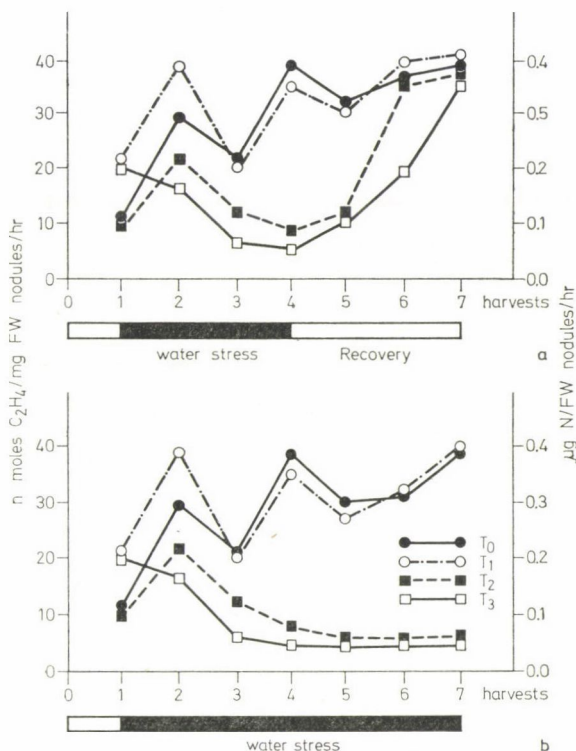


Fig. 1. Effect of water stress on nitrogen fixation (acetylene reduction) of *M. sativa*. (a) Water stress for seven weeks, (b) water stress and T_0 , field capacity; T_1 , 66.6%; T_2 , 33% and T_3 , 16.5% of the field capacity. Values correspond to average of four samples

graph with a hydrogen flame ionization detector. Calculations of C_2H_4 production were based on peak heights using calibration curves for known volumes of C_2H_4 .

Estimation of Dry weights and total nitrogen. After assay, the nodules were picked, their fresh weights were determined and the dry weights ($80^\circ C$ overnight) were found. All five replicates of each treatment were pooled, ground, and the N_2 content of two samples from each were determined colorimetrically using the Nesslerization method (ALLEN 1959).

Effect of water stress on $N_2(C_2H_2)$ -fixation. Fig. 1a shows the effect of different levels of soil moisture on the C_2H_2 -reducing activity and the concomitant calculated N_2 -fixation of *M. sativa*. It appears that the $N_2(C_2H_2)$ -fixation by plants growing under 66% of the field capacity (T_1 treatments) was almost of the same order of magnitude as that of plants growing under full field capacity (T_0 treatment). The $N_2(C_2H_2)$ -fixation by T_1 plants did in fact exceed that of the control at several points of the $N_2(C_2H_2)$ -fixation curve. The $N_2(C_2H_2)$ -fixation by plants growing under 33% and 16.5% of the field capacity (T_2 and T_3 treatments, respectively) was, however, adversely affected after two weeks of water stress and the $N_2(C_2H_2)$ -fixation by these plants dropped to less than 25% of the rate in T_0 and T_1 plants.

In another experiment, the $N_2(C_2H_2)$ -fixing activity was assessed in plants subjected to water stress for three weeks, then supplied with water to the field capacity level (Fig. 1b). A steady increase in the $N_2(C_2H_2)$ -fixing activity was observed, although it was slower in the T_3 treatment. However, both treatments regained their $N_2(C_2H_2)$ -fixation capacity after a 3-week recovery period.

An examination of the nodules of plants growing under water stress revealed that in T_1 and T_2 plants, nodule formation and appearance was not affected by the water regimes imposed, whereas the nodules in the T_3 treatment showed obvious shrinkage and desiccation.

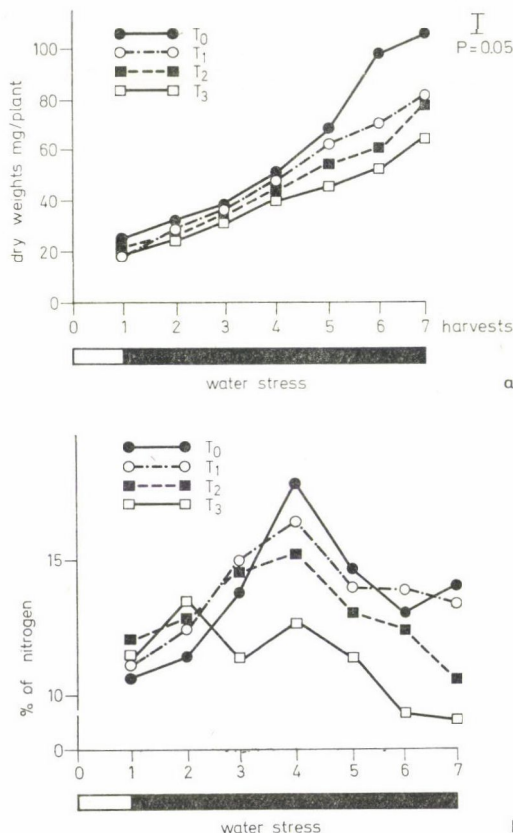


Fig. 2. Effect of the four water regimes on (a) dry weight of whole *M. sativa* plants, (b) total nitrogen content, expressed as a percentage of dry weight. Symbols as in Fig. 1

Since the nodules were not shed or crushed as a result of water stress, it is suggested that the decrease in the $N_2(C_2H_2)$ -fixing activity of T_2 and T_3 plants could be due to physiological effects.

Effect of water stress on growth and nitrogen content. Dry matter accumulation was determined at weekly intervals after $N_2(C_2H_2)$ -fixation measurements were made. The yield of whole *M. sativa* plants is shown in Fig. 2a. It is clear that there was a significant difference ($P = 0.05$) between the dry matter accumulation of water stressed plants and those growing under field capacity, but this difference was only observed after five weeks of stress treatment. On the other hand, differences in dry matter production between the treatments T_1 , T_2 and T_3 were insignificant. Other experiments (not presented in the results) showed that a significant increase ($P = 0.05$) in the root/shoot ratio occurred with T_2 and T_3 treatments.

Results of the analysis of the percentage nitrogen content are presented in Fig. 2b. It is clear that the nitrogen percentage did not vary significantly except in the severe stress treatments. However, the total nitrogen content estimated by Nesslerization is higher than the calculated N_2 based on the C_2H_2 reduction assay. Nevertheless, the nitrogen content reflected the total plant growth expressed as dry matter accumulation.

The data presented here show that only severe water stress can retard the nitrogen-fixing activity and consequently the growth and nitrogen content of *M. sativa*. Plants growing under mild water stress, i.e. in 66% of the field capacity, fixed nitrogen at almost the same rate as plants growing under conditions of adequate water supply (Fig. 1a). This observation is of special interest since such a situation may occur frequently in cultivation in semiarid and dry zones, where *M. sativa* is commonly used as a fodder plant. *M. sativa* is well recognized as a drought resistant plant and the active $N_2(C_2H_2)$ -fixation obtained by plants growing under mild water stress might be attributed to the resistance of the nodules of this species to such moisture stress.

SPRENT (1972a, b), ENGIN—SPRENT (1973) and GALLACHER—SPRENT (1978) reported that the depressing effect of water stress on growth and N_2 -fixation in soybeans and on clover nodule activity was significantly reduced when the plants were supplied with 75% of the optimum amount of water, whereas 66% of the optimum water supply did not affect nodule activity in *M. sativa*. However, with a supply of 33% and 16.5% of the field capacity, $N_2(C_2H_2)$ -fixation was considerably depressed after 3 weeks of stress treatment. The nodules of T_2 plants were apparently healthy, so the adverse effect on $N_2(C_2H_2)$ -fixation could be due to retardation effects in the N_2 -fixing tissues within the nodules.

A link between respiration and N_2 -fixation has long been established (GALLACHER—SPRENT 1978). Legume nodules need a definite concentration of O_2 to carry out oxidative phosphorylation and to produce their own ATP. BERGERSEN—GOODCHILD (1973) concluded that the prime effect of water stress on nodules was to depress the O_2 uptake, which in turn reduces the respiratory activity. Recent evidence indicates that the loss of activity in water-stressed nodules could be due to the development of an O_2 diffusion barrier in the nodule cortex (PANKHURST—SPRENT 1975).

Furthermore MINCHIN—PATE (1975) suggested that water stress could limit N_2 -fixation by restricting the rate of transfer of materials from the nodules. This means an increase in the nitrogen content within the nodules, which may inhibit further $N_2(C_2H_2)$ -fixation.

On rewetting the plants to field capacity, almost complete recovery was achieved (Fig. 1b) and the $N_2(C_2H_2)$ -fixing activity increased to a rate similar to that of the control plants. ENGIN—SPRENT (1973) reported similar observations with clover. They attributed this to the meristematic nature of clover nodules. Similarly, nodules of *M. sativa* are of the elongated and meristematic type. On rewetting, the meristematic activity may be resumed within a few days. Numerous other examples of the rapid resumption of meristematic activity following rewetting have been reported in the literature (SPRENT 1968). Water stress treatments altered the plant growth and weight. LEVITT (1972) reported that water stress may be expected to inhibit photosynthesis and the translocation of photosynthetic products, and, to a certain extent, to enhance leaf respiration. When these three changes occur, the net result must be a decrease in reserve carbohydrates, i.e. a starvation effect which will consequently result in a decrease in the dry matter yield. The present data on total nitrogen enable a more direct comparison to be made between estimates based on C_2H_2 reduction and total nitrogen incorporated. The number of such comparisons is limited in the literature (ENGIN—SPRENT 1973, GALLACHER—SPRENT 1978). The fixed N_2 calculated on the basis of the C_2H_2 reduction assay does not completely account for the total nitrogen content estimated by the Nesslerization method. HARDY *et al.* (1971), working on soybeans, found that C_2H_2 reduction estimates were slightly lower than those with Kjeldahl analysis and that the difference between the two increased with age; this was more pronounced in pot-grown plants. Such observations may apply to the results of the present investigation. It could be assumed that the former

method estimates the enzyme present, which may not have been functioning at full potential due to limiting factors.

However, it is clear from the data that the total nitrogen content of the plants was considerably affected by water stress and our results are comparable with those found on *Vicia faba* (GALLACHER—SPRENT 1978) and *M. lupula* (FOULDS 1978a).

The interesting features of our results are that under mild water stress, *M. sativa* can actively fix nitrogen. Under severe water stress, however, the data support previous observations that water stress has a quantitatively different effect on N_2 -fixation.

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SELECTION PARAMETER AGAINST LOW TEMPERATURE STRESS IN RICE (ORYZA SATIVA L.)

In India rice is grown under diverse geographical conditions, ranging from the Kashmir valley to sea level. Due to the diverse geographical setup, the environmental conditions vary greatly from region to region. At high altitudes stress caused by low temperature is prevalent and in the plains a similar situation develops when transplanting is delayed due to the late arrival of the monsoon rain.

Excluding the time for germination and seedling establishment the growth duration of a rice plant can be divided into three major phases, namely, vegetative growth, floral development and grain ripening. During the growth period the influences of temperature and other environmental factors establish mutual relationships between the morphology and the pattern of physiological responses, which make it difficult to consider any yield attribute or growth phase separately. This difficulty is increased by apparent differences in sensitivity to low temperature in each growth phase.

NOGUCHI (1960), HOSHINO *et al.* (1969) and OWEN (1969) stated that low temperature stress during jointing and flowering is the major obstacle to the delivery of full yield potential and to the adaptation of high yielding varieties in any particular region. OWEN (1971) pointed out that the temperature up to the panicle initiation stage determines the maximum yield potential attainable and the subsequent temperature can only influence the extent to which this potential is realized.

The present investigation was carried out with the aim of providing breeders with a simple norm for selecting rice cultivars suitable for the low temperature stress obtaining due to the late arrival of the monsoon on the plains. Further, the results obtained from this study will aid in quantifying the contribution of different traits for achieving higher grain yield in rice cultivars.

Nine rice cultivars differing widely in their maturity periods and physiological characters were included in a field experiment during the wet seasons of 1976 and 1977 at IARI, Regional Research Station, Kanpur. One-month-old seedlings were transplanted at four different dates at an interval of 20 days starting from 16th July (optimum transplanting time; SINGH—BHATTACHARYA 1975) in a well puddled field having a basal dose of 60 kg P_2O_5 /ha, 60 kg K_2O /ha and half the total nitrogen recommended for each variety. A randomized block design with three replications was adopted with a plot size of 5.0×2.5 metres with distances from row to row and hill to hill of 25 and 15 cm, respectively. The remaining half of the nitrogen was applied in two equal parts at maximum tillering and 50% panicle emergence. The crop was sprayed with insecticides and fungicides and irrigated as required. Observations were recorded on the following characters:

1. Total degree days or heat sum as the sum of the average temperatures per day from sowing to 50% panicle emergence.
2. Total dry matter (straw plus grain) yield per plot.
3. Grain yield per plot.
4. Leaf area (length \times width) of the top three leaves, i.e. flag leaf, 1st leaf and 2nd leaf, measured at 50% panicle emergence.
5. Leaf number as the mean of the total green leaves in 10 shoots at 50% panicle emergence.
6. Percentage of panicle bearing shoots, worked out from the number of shoots and panicles per 10 hills at maturity.
7. Plant height was taken from soil level to the neck of the panicle at harvest.

Analysis of variance was done for each trait. Simple correlation coefficients and regression coefficients were worked out from the variance and covariance components according to FISHER (1954) and ALJIBOURI *et al.* (1958) for each pair of traits. The association or dependence of different traits on the heat sum during the pre-flowering period and on the grain yield was calculated from regression coefficients and variances according to HAYES *et al.* (1955).

The differences between the cultivars and the dates of sowing studied were significant for all the traits (Table 1). The total degree days, grain yield, total dry matter yield, flag leaf area, 1st leaf area, 2nd leaf area, leaf number, ear bearing percentage of shoots and plant height ranged from 3540.2 to 2113.7, 5.05 to 0.01 kg, 19.0 to 3.25 kg, 63.48 to 7.38 cm^2 , 70.32 to 5.43 cm^2 , 62.49 to 1.89 cm^2 , 6.40 to 0.9, 97.76 to 6.38 and 144.8 to 14.3 cm^2 respectively. There was a wide range of variation in traits such as leaf area, grain yield and total dry matter yield, whereas the variations for the rest of the traits were comparatively low as shown by the coefficients of variation. The coefficients of variation for the different traits studied ranged from 1.70% (heat sum during pre-flowering period) to 17.38% (2nd leaf area).

Table 1
Range and estimates of variances due to cultivars and dates of sowing in rice

	Total degree days in pre-flowering period	Grain yield, kg	Total dry matter yield, kg	Flag leaf area, cm ²	1st leaf area, cm ²	2nd leaf area, cm ²	No. of green leaves/shoot	Ear bearing in shoot, %	Plant height, cm
Range	3540.2—2133.7	5.05—0.01	19.0—3.25	63.48—7.38	70.32—5.43	62.49—1.89	6.40—0.90	97.76—6.38	144.80—14.30
Total treat- ment variance	341644.5834**	6.1704**	34.1290**	434.2675**	409.4735**	343.4546**	0.6874**	896.0477**	2482.7895**
Variety variance	920773.1712**	1.9794**	16.9218**	695.8858**	910.3984**	824.2149**	0.5511**	941.2752**	6326.6598**
Treatment variance	785865.3666**	55.3304**	290.4126**	2443.0813**	1624.1749**	1246.6010**	2.4374**	3340.4983**	10327.5662**
V×T variance	93074.1229**	1.4224**	7.8292**	95.9597**	90.6608**	70.3079**	0.5141**	575.3956**	220.9024**
Error variance	1832.3682	0.0379	1.4859	8.8264	8.6178	11.5461	0.0350	40.3098	10.7255
S.e. (M) ± of total treat- ment	34.5	0.24	0.99	2.43	2.40	2.77	0.15	5.18	2.67
S.e. (M) ± of variety	17.5	0.12	0.50	1.21	1.20	1.39	0.08	2.59	1.34
S.e. (M) ± of treatment	11.7	0.08	0.33	0.81	0.80	0.92	0.05	1.73	0.89
C.V. %	1.70	11.14	11.51	10.69	11.13	17.38	7.66	7.95	5.33

“Treatment” is for dates of sowing. ** Significant at 1.0% probability

Table 2

Estimates of simple correlation coefficients of different characters in rice

	Grain yield	Total dry matter yield	Flag leaf area	1st leaf area	2nd leaf area	No. of leaves/shoot	Ear bearing in shoot, %	Plant height
Total degree days during P.F. period	+0.4636*	+0.1663	+0.4216*	+0.5863**	+0.5378**	+0.2596	-0.3473*	+0.3206
Grain yield		+0.7937**	+0.5379**	+0.3976*	+0.3770*	+0.5021**	+0.6000**	+0.3903*
Total dry matter yield			+0.3509*	+0.7713**	+0.7097**	+0.6273**	+0.5614**	+0.6488**
Flag leaf area				+0.7632**	+0.8043**	+0.5046**	+0.3846**	+0.8858**
1st leaf area					+0.9532**	+0.6732**	+0.3616*	+0.8536**
2nd leaf area						+0.7065**	+0.3445*	+0.8450**
No. of leaves/shoot							+0.5624**	+0.4315**
% ear bearing in shoot								+0.4330**

P.F. = pre-flowering period *, ** significant at 0.5% and 1.0% levels of probability

Table 3

Estimates of regression coefficients and associations of different traits with degree days in pre-flowering period and yield in rice

	Regression		Association, %	
	total degree days	grain yield	total degree days	grain yield
Grain yield	+39.13	—	2.76	—
Total dry matter yield	+46.39	+0.34	22.77	63.01
Flag leaf area	+11.82	+0.06	17.77	28.93
1st leaf area	+16.94	+0.05	34.39	15.81
2nd leaf area	+16.96	+0.05	28.92	14.27
No. of green leaves/shoot	+183.01	+1.50	6.74	25.21
Ear bearing in shoot, %	-6.78	+0.02	12.06	15.24
Plant height	+3.76	+0.05	10.27	36.00

The simple correlation coefficients of total degree days with grain yield and leaf area were positively significant whereas that with ear bearing percentage of shoots was negatively significant (Table 2). The correlations between total degree days with total dry matter yield and plant height were not significant. The grain yield was significantly correlated with all the traits studied and the correlations were positive. The grain yield and the flag leaf area had a high positive correlation ($r = +0.5379$) while with other leaf areas the correlations were positive but low ($r = +0.3976$ and $+0.3770$). This is in agreement with the findings of TANAKA (1961) and BHATTACHARYA—SINGH (1978).

Grain yield and ear bearing tillers were in positive correlation, which confirms earlier reports (BHIDE—BHALERAO 1927, NARSINGARAO 1937, MATSUSHIMA—YAMAGUCHI 1953, RAMIAH 1953, EIKISHI ISO 1954, CHANDRAMOHAN 1964, GHOSH *et al.* 1966, AHMED—RAO 1967, ROYCHOUDHARY 1967, SASTRY *et al.* 1967, SARATHE *et al.* 1969). However, MISHRA *et al.* (1973) reported a negative correlation between grain yield and ear bearing tillers. The significant positive correlation between the grain yield and plant height was in agreement with the results reported by ABRAHAM *et al.* (1954), but EUNUS *et al.* (1974) reported a significant negative correlation between grain yield and plant height.

Through the estimation of regression coefficient and the association or dependence of different traits on the total degree days and on grain yield (Table 3) it is quite evident that the heat sum during the pre-flowering period has very little effect on grain yield and leaf number. The very low dependence of the leaf number on the heat sum can be explained by the fact that the leaf number is a genetically controlled character and is predetermined and therefore remains unaffected by the change in the heat sum. The nominal dependence of the grain yield on the heat sum during the pre-flowering period can be explained by the report made by OWEN (1971) where he stated that "the temperature up to panicle initiation can determine the maximum yield potential attainable and the subsequent temperature can only influence the extent to which this potential is realized".

The high degree of dependence of the grain yield on the top three leaves is in confirmation of the report made by TANAKA (1958). Of the top three leaves, the flag leaf stands out as having the greatest effect, as the grain yield was dependent on it by 29% as compared with the other leaves studied, where the association was 16% and 14% respectively. Similar results were obtained by ENYI (1962) and TANAKA (1961).

Among the morphological characters the flag leaf area and the plant height were mostly associated with the grain yield, the correlation being 29% and 36% respectively. Of these traits the flag leaf area is more dependent on the heat sum during the pre-flowering period than is the plant height, which suggests that the flag leaf area is more susceptible to low temperature than the plant height. The dependence of grain yield on the total dry matter production was the highest among the traits studied (63%).

Keeping the above experimental findings in view the flag leaf area at 50% panicle emergence is obviously the most suitable and sensitive parameter for selecting rice plants against low temperature stress, because the dependence of the flag leaf area on the total degree

days during the pre-flowering period and the dependence of the grain yield on the flag leaf area are quite high. However, the total dry matter production has a high degree of association with the heat sum and the highest correlation with grain yield, but the time factor for observing this trait becomes limiting as compared to the flag leaf area at 50% panicle emergence. The plant height can also be considered as another selection parameter due to its high degree of association with the grain yield.

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CHARACTERISTICS OF AN INHIBITORY FACTOR FROM CROTON BONPLANDIANUM BAILL

Considerable evidence has accumulated during the past few decades, demonstrating the presence of phytotoxic compounds in a wide variety of extracts and volatiles (BONNER 1950, BÖRNER 1960, EVENARI 1961, WHITTAKER 1970, MULLER—CHOU 1972, DATTA—SINHA-ROY 1974).

An investigation was set up to determine the possible occurrence of inhibitors in common crop and weed species. DATTA—SINHA-ROY (1973) reported the prevalence of an inhibitory fraction in various organs of *Croton bonplandianum*, a perennial weed of widespread distribution in India. They also indicated that the phytotoxin contained in the leaves of *C. bonplandianum* acts as a deterrent to the growth of other plants with which the species is associated (DATTA—SINGHA-ROY 1975).

Further work was done to ascertain the biological and physical traits of the leaf extract of *C. bonplandianum*.

C. bonplandianum plants, harvested from sites near Calcutta during 1967—71, were used to make stock solutions for the experiments described. Such solutions were prepared by crushing 100 g fresh leaves with 200 ml glass-distilled water in a mortar and pestle. The extract was filtered through Whatman No. 1 filter paper and the filtrate made up to 250 ml with distilled water. The concentrations were expressed as 1/1, 1/2, 1/4, 1/8, 1/16, 1/32 and 1/64 to denote the quantity of material diluted with 0, 2, 4, 8, 16, 32 and 64 times the volume of water from the stock solution.

Four different bioassays were employed to judge the inhibitory activity of the various solutions. Seeds of pea (*Pisum arvense* Moris) and mustard (*Brassica juncea* Czern. and Coss.) were collected near Calcutta, while lettuce (*Lactuca sativa* L. cv. Improved Unrivalled) and rice (*Oryza sativa* L. cv. Karticksal) were secured from Sutton's, Calcutta and the Rice Research Station, Chinsurah, West Bengal, respectively. The bioassay consisted of keeping surface-sterilised (2% sodium hypochlorite for 10 min) seeds in a sterile Petri dish (11 cm diam.) which had a single layer of filter paper and 10 ml test solution (or distilled water for control). There were three parallels for each treatment and most of the experiments were repeated. In the tests with lettuce and mustard 100 seeds were used per dish, whereas the corresponding number for pea was 25 and for rice 50. The dishes were covered and kept for three days (seven days for rice) at $28 \pm 4^\circ\text{C}$. Seeds with protruded radicles were counted to assess the success of germination. At the same time, the lengths of the root and hypocotyl of 20 seedlings were measured to the nearest mm. The values are given as means \pm standard error. Any value of

germination below that of the control was considered to be germination inhibition. Likewise, growth inhibition was estimated by comparing the elongation growth of treated seedlings with those grown on water.

C. bonplandianum leaf extract had practically no effect on pea germination. The germination of mustard, rice and lettuce was seriously affected. Increasing the amount of leaves in the aqueous extract caused a significant lowering of the germination and growth responses. While this effect was evident in mustard up to 1/32 concentration, it was only observed in rice and lettuce up to 1/8 concentration. Both rice and lettuce failed to germinate in the most concentrated extract, the effect of which was neutralised with higher dilutions.

Experiments were made to see if the leachate (obtained by soaking fresh leaves in water for three or seven days) was inhibitory. The leachate from leaves soaked for three days was more detrimental to lettuce than to mustard and rice; the leachate decreased root growth rather than hypocotyl growth. While all these effects were obvious at 1/1 concentration, the inhibitory activity accelerated with the leachate from leaves soaked for seven days. In the latter, both germination and growth inhibitions were conspicuous in concentrations lower than 1/2. Though pea germination remained unaffected by the two leachates, the root growth suffered more than the hypocotyl growth.

Attempts were made to determine the solubility of the inhibitor. The first extract contained most of the activity. At maximum concentration, the first extract caused very strong inhibition (except in pea). The second and third extracts from the same leaf material induced no deleterious effects.

A bioassay of the aqueous extract of *C. bonplandianum* leaves in various stages of maturity suggested that the inhibitory component decreased as the leaf matured.

Other experiments indicated that germination was inhibited under dark conditions, which became evident at full concentration. In mustard, germination percentages which remained low in the extract under diffuse light and continuous dark improved with dilutions of the extract and under continuous light. At higher concentrations of the extract, there was little or no germination in rice under diffuse and continuous light. At full concentration and under the two light conditions, lettuce did not germinate at all. There was repression in root and hypocotyl lengths for pea in the dark at full concentration. But mustard exhibited reduced root and hypocotyl growth under continuous light. While continuous light at full concentration only encouraged the production of hypocotyl in rice seedlings, there was complete suppression of root and hypocotyl growth in this test species under darkness and diffuse light.

At full concentration, lettuce failed to germinate in winter and summer. Rice germinated in summer and not in winter. But pea gave low germination under darkness in both winter and summer. Finally, the germinability of mustard was lower in winter than in summer. At the level of seedling growth, the root lengths of pea were considerably shortened in the two seasons under darkness. In mustard seedlings, root growth was more inhibited than hypocotyl growth and inhibition was greater in winter than in summer under light. Whereas rice seedlings formed roots and hypocotyls in summer, these organs did not emerge in winter.

A comparison of an aqueous extract of dry leaves with that of fresh leaves revealed that the former resulted in the loss of some activity even though inhibition was still sustained. While the extract of dry leaves lowered the germination and growth values of both mustard and rice up to 1/2 concentration, the extract of fresh leaves similarly restricted germination and growth of these two species up to 1/8 concentration.

Boiling the stock solution caused little decline in the inhibitory activity, as both germination and seedling growth were below the comparable controls. Subjecting the solution to chilling (8°C) or to storage at 30°C resulted in slightly diminished activity at the lower temperature and some loss of activity at the higher temperature.

Experiments were carried out to determine if washing the plant material in water could remove inhibition. The germination of pea, mustard and rice was not affected by the extract of washed leaves. Such an extract only inhibited the germination of lettuce at the highest concentration. The extract was more effective in rice than in mustard and pea. In rice, both root and hypocotyl lengths were depressed at 1/1 and 1/2 concentrations as compared to the control set. In both pea and mustard, the root length decreased at 1/2 concentration, while the hypocotyl length was only reduced for mustard. Like the extract, the germination of pea, mustard and rice was not affected by the leachate of washed leaves. Such a leachate did not affect the germination of lettuce even at the maximum concentration. The effect of the leachate was more marked in rice than in pea and mustard. Even in rice, the root lengths were reduced at 1/1 and 1/2 concentrations in comparison with the corresponding control. While the extract was more inhibitory than the leachate, both lost their activity after the leaves were washed. Nevertheless, the extract from unwashed leaves caused greater inhibition than that from washed leaves.

It was noted, particularly in the mustard bioassay, that the pH of the leaf extract increased and became alkaline (8.5) during the period of germination and growth. The addition of KH_2PO_4 to the extracts in amounts sufficient to overcome any pH change did not alter the so-called adverse effect.

The germination percentage of rice with alkaline (pH 11.0) autoclaved extract did not differ much from the unautoclaved original extract but differed a great deal from the unautoclaved water control. With acidic (pH 2.0) autoclaved extract, the germination percentage of rice did not vary appreciably from the control although the unautoclaved extract gave poor germination. In lettuce, the germination percentages with autoclaved and unautoclaved extracts were far below the control. Moreover, the alkaline autoclaved extract induced low germination as compared to high germination by the acidic autoclaved extract. The root and hypocotyl lengths produced by the unautoclaved extract were fairly similar to their counterparts produced by the alkaline autoclaved extract. However, these values were far below the control. The acidic extract caused higher root and hypocotyl lengths compared to the alkaline extract and lower root and hypocotyl lengths compared to the unautoclaved water control. It seemed that the inhibitory constituent of *C. bonplandianum* was more dialysable and stable to autoclaving at pH 2.0. The unautoclaved extract was also more inhibitory than the autoclaved ones.

Compared to the untreated leaf extract, the germination of rice and lettuce seeds was higher in Norit (activated carbon)-treated samples. With 5 and 10 g Norit, germination was low in contrast to the treatments with 15 and 20 g. Moreover, an increase in the amount of Norit to the extract was still capable of inhibiting germination to some extent. In comparison with the untreated extract, dilutions of Norit-treated extract gradually erased the germination inhibition of both rice and lettuce. At full concentration, there was inhibition of both root and hypocotyl growths of rice in all Norit-treated solutions as compared to the water control. At 1/2 and 1/4 concentrations, seedling growth resulting from Norit treatments did not differ appreciably from the control. On comparing the untreated extract with the treated ones, it appeared that both root and hypocotyl lengths were not reduced with increments of Norit. Furthermore, increasing the quantities of Norit progressively did not decrease the root and hypocotyl lengths proportionally. The biotest of the filtrates from Norit-treated samples thus proved that inhibition was considerably reduced. However, the addition of increasing quantities of Norit did not eliminate all the inhibitory activity from the original extract.

Compared to the leaf extract, neither inhibition of germination nor inhibition of growth was caused by adding the ash solution to dishes containing the test species. The ash represented 10% of the original sample.

To investigate whether there is any adverse effect of the inhibitor on plant growth under field conditions, the stock leaf extract was applied to potted plants. With soil application, the phytotoxic symptoms in pea and mustard plants included the formation of chlorotic spots on the leaves. The mustard plants had no chlorosis, but chlorotic symptoms developed in mustard plants after spraying. In sprayed pea plants, the symptoms ranged from chlorosis to wilting of the leaves and from twisting to withering of the stems. While no death took place in rice and mustard plants after spraying, some of the pea plants died following this treatment. If the two treatments are compared, pea plants were more affected by spraying than by soil application. Furthermore, the shoot growth of pea was promoted 14 days after soil application and that of mustard inhibited after spraying. In this connection, it is worthwhile mentioning that LE TOURNEAU—HEGGENESS (1957) saw no adverse effects on plant growth when extracts of leafy spurge foliage and quackgrass rhizomes were sprayed on bean, tomato and wheat foliage.

Experiments were carried out to determine the fate of the inhibitor. Decaying leaves had some inhibiting effect on the germination of rice and mustard seeds, a greater phytotoxicity being displayed by increasing incorporation of the leaf material with the soil. There was, however, no effect on the germination of peas. In all instances, there was inhibition of root growth as well as hypocotyl growth. As the concentration of leaves in the soil was raised, the growth of crop seedlings progressively declined. Although maximum root inhibition occurred in mustard seedlings, the use of 10 g leaves per 450 g soil was considered adequate to bring about more than 50% inhibition of both root and hypocotyl growth.

No particular trend of germination inhibition was caused by the soil samples collected in October (Table 1). The germination percentages of pea, mustard and rice were slightly lower in soils of the July collection, the inhibition being uniformly high in sample IV for the respective crop seeds. The results on seedling growth did not show any specific trend of growth inhibition with the soils of the October collection (Table 2). The seedling growth of pea, mustard and rice decreased with the samples collected in July. In general, root and hypocotyl lengths were uniformly reduced in all the July soil collections. Sample III showed the greatest

Table 1

Germination percentage of crop seeds in field soils previously in contact with roots of C. bonplandianum

Test seed	Date of soil sampling	Control	Sample I	Control	Sample II	Control	Sample III	Control	Sample IV
Pea	July	98.6 ±1.3	91.3 ±5.4	97.0 ±2.0	96.0 ±4.0	98.0 ±2.0	93.0 ±6.0	98.6 ±1.3	90.0 ±8.0
	October	98.0 ±2.0	98.6 ±1.3	93.0 ±3.0	97.3 ±2.5	96.0 ±4.0	96.0 ±3.0	96.0 ±2.0	97.3 ±2.4
Mustard	July	74.0 ±4.0	70.0 ±5.0	81.3 ±4.6	66.6 ±3.5	88.0 ±10.0	73.7 ±7.3	76.0 ±4.0	60.0 ±3.0
	October	78.7 ±2.3	68.3 ±5.7	78.6 ±7.4	73.0 ±6.0	80.0 ±3.0	82.0 ±0.9	72.3 ±6.3	84.0 ±2.0
Rice	July	86.7 ±3.3	80.0 ±4.0	93.0 ±5.0	77.3 ±4.7	89.3 ±5.2	79.0 ±6.0	93.3 ±6.3	73.3 ±4.5
	October	34.0 ±4.5	33.3 ±3.2	36.7 ±4.7	42.7 ±6.2	36.0 ±3.0	30.7 ±2.6	48.4 ±2.0	49.3 ±11.2

inhibition of root growth for all crop seedlings. It is noteworthy that the active growth of *C. bonplandianum* takes place in July and the leaf-litter of the plant accumulates in October.

Autoclaving of the leaf extract caused a slight reduction in inhibitory activity when mustard and rice were used as the test seeds. Inhibition was different when lettuce achenes were employed for the bioassay: there was no loss of activity in this case. Perhaps the reduction in inhibition is such that it could not be detected by this conventional bioassay. This bioassay was not so sensitive in the autoclaved extract treated with soil to which the leaf extract had previously been applied. It is also possible that microorganisms other than *Rhizopus* are responsible for the loss of activity. The loss of activity in the soil has been attributed to the inhibitor being subjected to microbial decomposition or adsorbed by colloids (LE TOURNEAU—HEGGENESS 1957). On the contrary, WILSON—RICE (1968) put forward the theory that the colloidal material in the soil may act in accumulating the phytotoxin to a toxic level. More information in this respect is needed before arriving at a definite conclusion.

Since the leaves of *C. bonplandianum* appeared to be phytotoxic, they were systematically extracted with various solvents and the extract from each solvent was assayed for inhibitor activity. Both petroleum ether and benzene extracts were inactive, but chloroform extract was mildly active and ethanol extract extremely active. As the ethanol extract retained the most activity, it was concentrated and examined with respect to its solubility in diethyl ether. Germination as compared to the control (98.7%) was 70% and 0% in the ether-soluble and ether-insoluble parts respectively. TLC experiments were done with the ether-insoluble part, using chloroform-benzene mixtures; the best separation was attained with a 4 : 1 solvent combination. It became evident that the activity was concentrated in fractions III and IV and not in fractions I and II. The active fractions, which appeared deep green under visible light, gave brick-red fluorescence under UV light at R_f values of 0.438 and 0.571 and yielded germination percentages of 0% and 20% respectively (Table 3).

That a mixture with very close R_f values would seem homogeneous could be proved if the active fractions were chromatographed with different solvent systems (Table 4). From the results, it was observed that fractions III and IV were homogeneous. By spraying the developed chromatograms of fractions III and IV with 2,4-DNP, Dragen Droof's reagent, 10% NaOH and FeCl_3 solution, no colour reactions were obtained. This test indicated that in the active fractions the carbonyl function might be hindered and that alkaloids, acids or phenolics were probably absent.

For confirmation of the chemical nature of fractions III and IV, the oily green residues from active fractions were taken and their UV absorption spectra determined. The absorption maxima for fraction III and fraction IV were 255 $m\mu$ and 275 $m\mu$ respectively. As the intensity of absorption could not be measured, it is difficult to arrive at definite conclusions. From the nature of the spectrum and the comparison of the absorption maxima of abscisic acid (251 $m\mu$)

Table 2*Lengths (cm) of root (R) and hypocotyl (H) of crop seedlings*

Test seedling	Date of soil sampling	Control		Sample I		Control	
		R	H	R	H	R	H
Pea	July	4.14	4.19	3.40	3.50	3.66	5.60
		± 0.23	± 0.11	± 0.14	± 0.24	± 0.34	± 0.40
	October	5.60	11.00	5.40	10.60	5.90	9.20
		± 0.45	± 0.70	± 0.44	± 0.72	± 0.10	± 0.40
Mustard	July	2.64	2.20	2.00	1.90	2.60	2.28
		± 0.73	± 0.23	± 0.20	± 0.13	± 0.30	± 0.22
	October	3.60	3.20	2.75	2.80	3.00	2.90
		± 0.30	± 0.20	± 0.25	± 0.20	± 0.10	± 0.30
Rice	July	8.00	6.20	7.00	5.40	6.58	5.16
		± 1.00	± 0.40	± 0.42	± 0.24	± 0.22	± 0.34
	October	5.40	3.54	5.00	3.20	7.00	3.50
		± 0.08	± 0.12	± 0.60	± 0.14	± 0.20	± 0.55

Table 3*Comparison of R_f values and relative activity of fractions from ether-insoluble part*

Fraction	R_f value	Colour developed		Germination percentage of lettuce		Inference
		under UV light	under visible light	treated	control	
I	0.071	Milky white	Colourless	87.0 ± 3.0	90.0 ± 2.0	Inactive
II	0.107	Pink	Colourless	81.0 ± 5.0	90.0 ± 2.0	Inactive
III	0.438	Brick red	Deep green	0 ± 0	90.0 ± 2.0	Extremely active
IV	0.571	Brick red	Deep green	20.0 ± 6.0	90.0 ± 2.0	Moderately active

Table 4*Comparison of R_f values of fractions III and IV from ether-insoluble part*

Solvent system	R_f value		Inference	
	Fraction III	Fraction IV	Fraction III	Fraction IV
Chloroform : benzene 4 : 1	0.438	0.571	Homogeneous	Homogeneous
Benzene : ethyl alcohol 1 : 1	0.970	0.976	Homogeneous	Homogeneous
Benzene : ethyl acetate 1 : 1	0.953	0.961	Homogeneous	Homogeneous

in field soils previously in contact with roots of *C. bonplandianum*

Sample II		Control		Sample III		Control		Sample IV	
R	H	R	H	R	H	R	H	R	H
2.86	4.81	3.20	3.20	2.20	2.20	2.22	3.58	1.51	2.45
±0.44	±0.29	±0.10	±0.10	±0.20	±0.20	±0.78	±0.42	±0.49	±0.55
5.94	10.80	5.00	10.60	5.12	12.60	6.60	13.00	5.00	13.60
±0.26	±0.20	±0.22	±0.30	±0.78	±0.44	±0.40	±1.00	±0.93	±0.97
1.90	1.60	2.98	2.44	2.00	1.90	2.42	2.10	1.96	1.60
±0.50	±0.42	±0.32	±0.46	±0.20	±0.10	±0.28	±0.10	±0.14	±0.23
2.40	2.62	2.64	3.00	2.58	3.00	2.40	2.00	2.70	2.28
±0.24	±0.28	±0.26	±0.27	±0.32	±0.10	±0.20	±0.00	±0.20	±0.22
5.50	4.45	7.20	5.40	6.00	4.20	6.10	5.40	5.40	4.60
±0.33	±0.35	±0.10	±0.45	±0.40	±0.32	±0.10	±0.50	±0.50	±0.42
7.28	3.54	5.50	3.45	5.40	3.60	6.00	3.37	6.34	3.52
±0.22	±0.26	±0.25	±0.50	±0.36	±0.44	±0.14	±0.45	±0.56	±0.62

and phaseic acid (258 $m\mu$) it could be stated that fractions III and IV might contain a carbonyl function. The IR spectra of both fractions showed major peaks at 3440 cm^{-1} and 1735 cm^{-1} , revealing the presence of hydroxyl and carbonyl groups respectively. It is very likely that abscisic and phaseic acids are involved in the allelopathic potential of *C. bonplandianum*, both in the extract or leachate from leaves and in that present in the leaf-litter or soils under *Croto* plants.

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SYMBIOTIC VS. FERTILIZER NITROGEN FOR CRUDE PROTEIN AND OIL PRODUCTION IN SOYBEAN [GLYCINE MAX (L.) MERR.]

Earlier reports from our laboratory examined the effect of symbiotic and fertilizer N on the grain yield (PAL—SAXENA 1975a) and N nutrition (PAL—SAXENA 1975b, 1976, SAXENA *et al.* 1976) of soybean. Nitrogen fertilization increased the yield as well as the N status of non-nodulating soybeans whereas no such response to N application was observed in the case of well nodulated soybeans. Data are lacking, however, on crude protein and oil contents and their yields in soybean as affected by symbiotic and fertilizer N under humid subtropical conditions, though some reports on these aspects are available from temperate countries such as the U.S.A. (NORMAN 1943, OHLROGGE 1960). Therefore, the objective of the present communication is to examine the effect, and consequently the suitability, of symbiotically fixed N and fertilizer N on the contents and yields of crude protein and oil in soybean.

Field experiments were conducted in the summer seasons of 1971 (Experiment 1) and 1972 (Experiment 2) at the Crop Research Centre of the G.B. Pant University of Agriculture and Technology, situated at 29°N and 79.3°E in a humid subtropical climate in the foothills of the Shivalik range of the Himalayan mountains. The experiments were conducted on silty loam soils, high in organic carbon (1.95 to 2.12%), total N (0.14 to 0.15%) and available phosphorus (32 to 38 kg P/ha) and medium in available potassium (208 to 229 kg K/ha), with a neutral soil reaction. In Experiment 1, soybean was planted on virgin soil with no prior history of soybean cultivation, whereas Experiment 2 was conducted on the field where well-inoculated soybeans were grown in previous seasons.

Plants of nodulating (inoculated and uninoculated) and non-nodulating isolines of Clark and Harosoy were raised, in triplicates, at 0, 25, 50, 100, 200 and 300 kg N/ha in a single split plot design. Isolines were allotted to the main plots and N rates to the sub-plots. The graded doses of N, as per treatments, were side-dressed at the time of planting, whereas 42 kg P/ha and 50 kg K/ha were uniformly applied, as basal application, in both experiments. The inoculation treatment was accomplished using a multi-strained peat-based 'Nitragin' inoculum. The plants were maintained at a spacing of 30 × 5 cm (6.6×10^5 plants/ha) in 6 × 1.8 m plots.

The crude protein content of the seeds was determined by assaying the total N content using the micro-Kjeldahl technique (JACKSON 1967). The oil content of the soybean seeds was determined by extracting the oil in ether using a Soxhlet apparatus. The crude protein and oil yields per hectare determined by multiplying the content values by the seed yield per hectare were reported elsewhere (PAL—SAXENA 1975a).

Data on bean yields and nodulation (PAL—SAXENA 1975a) and N nutrition (PAL—SAXENA 1975b, 1976) have been discussed elsewhere. In summary, the inoculated nodulating isolines of both Clark and Harosoy had profuse nodulations as against no nodulation in uninoculated nodulating and non-nodulating isolines in 1971 (Experiment 1), when soybean was grown on soil with no prior history of its cultivation. On increasing the N rate from 0 to 300 kg N/ha, nodulation decreased from 21 to 8 mg and from 227 to 138 mg dry weight of nodules/plant in Clark and from 34 to 18 mg and from 309 to 117 mg dry weight of nodules/plant in Harosoy at 35 and 65 days, respectively. In Experiment 2, however, nodulation occurred in the nodulating isolines of both Clark and Harosoy, irrespective of inoculation, to an almost identical extent. As in Experiment 1, higher N rates depressed the nodulation in Experiment 2 too. The absence of nodulation in the uninoculated treatment, as observed in Experiment 1, is not unusual and has been reported by several workers, including BHARGAVA *et al.* (1974), who grew soybean on virgin soil or on cultivated soils with no soybean cultivation in the past.

The yield data could be summarised by stating that N rates had little or no effect on the bean yields of nodulated isolines of Clark and Harosoy, the average yields (over all N rates) being 2160 kg/ha for inoculated nodulating Clark and 2240 kg/ha for inoculated nodulating Harosoy in Experiment 1, while the average yields were 3140 kg/ha for inoculated nodulating Clark, 3080 kg/ha for uninoculated nodulating Clark, 2450 kg/ha for inoculated nodulating Harosoy and 2170 kg/ha for uninoculated nodulating Harosoy in Experiment 2. By contrast N application increased the bean yields of non-nodulating isolines in both experiments and also of uninoculated nodulating isolines in Experiment 1, which exhibited no nodulations. The maximum increases in bean yields due to higher N rates (200 or 300 kg/ha) over the no-nitrogen control were 268% (i.e. from 380 to 1400 kg/ha) and 156% (i.e. from 660 to 1690 kg/ha) in non-nodulating isolines of Clark and Harosoy, respectively, in Experiment 1. The corresponding increases were 236% (i.e. from 840 to 2820 kg/ha) and 144% (i.e. from 890 to 2170 kg/ha) in Experiment 2. In Experiment 1, uninoculated nodulating Clark and Harosoy demonstrated 300% (i.e. from 450 to 1900 kg/ha) and 56% (i.e. from 1180 to 1840 kg/ha) increases in bean yields respectively, over the no-nitrogen control when supplied with higher

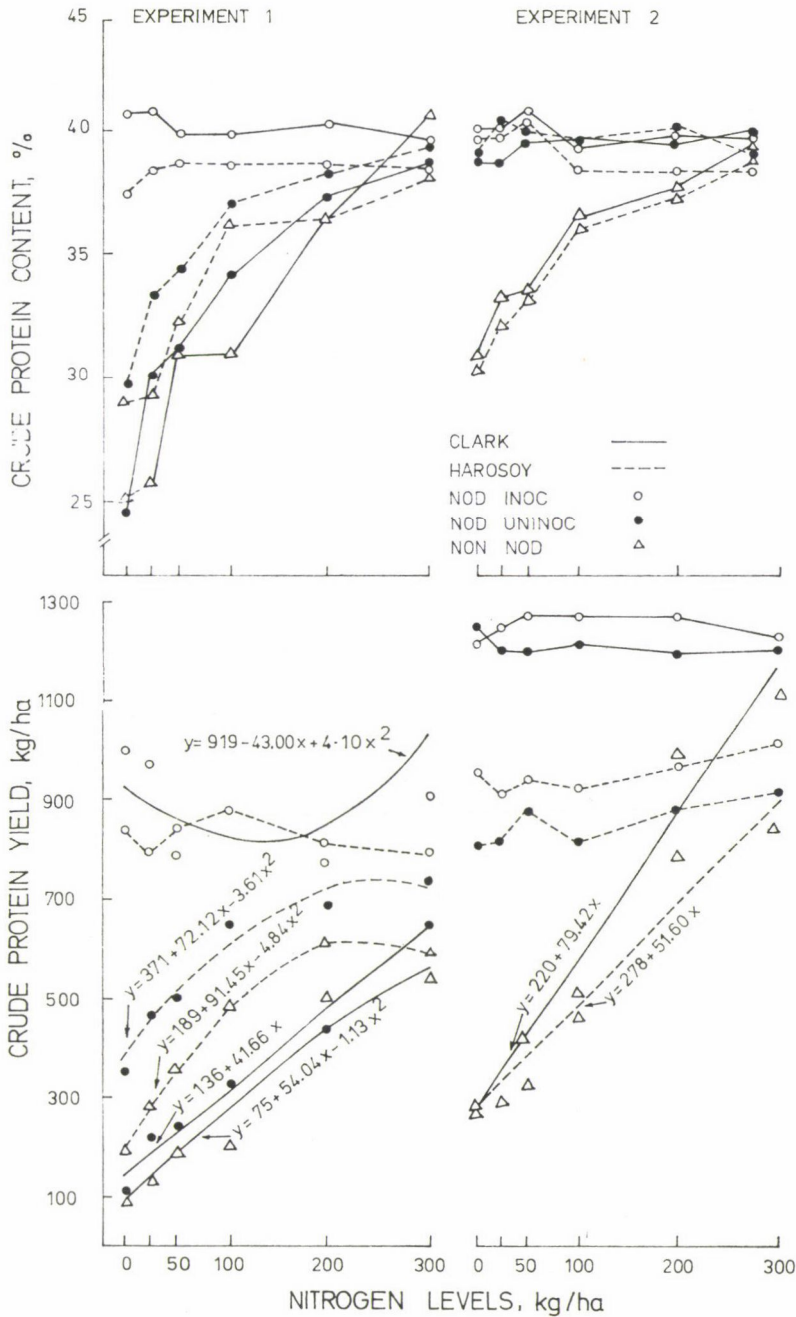


Fig. 1. Effect of N rates on crude protein content and crude protein yield of nodulating and non-nodulating soybeans. The response functions of N rates on crude protein yield were only fitted to those isolines that exhibited a significant response to N fertilization. One unit of 'X' equals 25 kg N/ha for the calculation of response equations

(200—300 kg/ha) N rates. These data, already discussed in detail, led to the conclusion that symbiotically fixed N is superior to fertilizer N for soybean production (PAL—SAXENA 1975a).

Crude protein content and crude protein yield. In Experiment 1, the crude protein content of inoculated nodulating isolines of both Clark and Harosoy was unaffected by N fertilization (Fig. 1). In contrast to this, uninoculated nodulating and non-nodulating isolines from both genetic backgrounds demonstrated a considerable increase in crude protein content due to N application. An application of 300 kg N/ha caused an almost identical increase of about 60% over the control in uninoculated nodulating and non-nodulating isolines of Clark, as against only a 33% increase over the control in the corresponding isolines of Harosoy.

In Experiment 2, N application had little effect on the crude protein content of nodulating isolines of Clark and Harosoy, irrespective of inoculation. Non-nodulating isolines from both genetic backgrounds, however, showed an increase in crude protein content due to N fertilization. Nitrogen application at the rate of 300 kg/ha caused a 28% increase over the control in non-nodulating isolines of Clark and Harosoy. In both experiments, 300 kg N/ha proved to be sufficient to bring the crude protein content of non-nodulating isolines to the level obtained in inoculated nodulating isolines (Fig. 1).

In Experiment 1, inoculated nodulating isolines from both genetic backgrounds did not show any improvement in crude protein yield, although there was a tendency for the crude protein yield to decrease in Clark at intermediate N rates (50—200 kg N/ha) (Fig. 1). The response curve for inoculated nodulating Clark indicated a minimum crude protein yield (806 kg/ha) at 130 kg N/ha. However, the depression in crude protein yield of inoculated nodulating Clark at intermediate N levels was nullified completely at 300 kg N/ha. By contrast, uninoculated nodulating Harosoy and non-nodulating isolines of both Clark and Harosoy demonstrated a significant quadratic increase in crude protein yield due to N fertilization, whereas a linear increase in crude protein yield up to 300 kg N/ha was observed in the case of uninoculated nodulating Clark (Fig. 1). The maximum increases in crude protein yield due to N fertilization were 482%, 500%, 108% and 220% over the control in uninoculated nodulating and non-nodulating isolines of Clark and Harosoy, respectively. However, even the application of 300 kg N/ha to uninoculated nodulating and non-nodulating isolines could not equalize the crude protein yield obtained at 0 kg N/ha in inoculated nodulating isolines. This suggests the superiority of symbiotically fixed N over fertilizer N for crude protein production. It was also interesting to note the same degree of increase in crude protein yield at each N level in both uninoculated nodulating and non-nodulating isolines with a Clark background, whereas with a Harosoy background, the uninoculated nodulating isolate had a tendency to produce a higher crude protein content than non-nodulating isolines at almost all N rates.

In Experiment 2, fertilizer N had little effect on the crude protein yield of nodulating isolines of Clark and Harosoy, irrespective of inoculation, though the nodulating isolines of Clark outyielded those of Harosoy significantly. By contrast, non-nodulating isolines with both genetic backgrounds responded to fertilizer N linearly up to 300 kg N/ha (Fig. 1). The response to N application was of almost the same order up to 100 kg N/ha in non-nodulating isolines with both genetic backgrounds. Beyond this level of N, non-nodulating Clark showed a much higher increase in crude protein yield than non-nodulating Harosoy. The maximum increases in crude protein yield due to 300 kg N/ha were 315% and 205% over the control in non-nodulating Clark and Harosoy, respectively.

Oil content and oil yield. Fig. 2 shows the effect of N rates on the oil content of the seed and the oil yield of different isolines of Clark and Harosoy. In Experiment 1, the oil content of the inoculated nodulating isolines of both Clark and Harosoy was not altered by N application. By contrast, oil content of the seeds decreased to 84% compared to the control in uninoculated nodulating and non-nodulating isolines of Clark when supplied with 300 kg N/ha. In the case of Harosoy, however, an application of 300 kg N/ha resulted in a decreased oil content (82% of the control) in both uninoculated isolines.

In Experiment 2, there was again very little effect of N fertilization on the oil content of the seed in nodulating isolines with both genetic backgrounds, irrespective of inoculation. As was observed in Experiment 1, the non-nodulating isolines of Clark and Harosoy again showed a decline of 26.0% to 21.9% (i.e. 84% control) and 25.9% to 21.7% (i.e. 84% of control), respectively, in the oil content with increasing N rates in Experiment 2 (Fig. 2).

The effect of N rates on the oil yield was about identical to that observed for the crude protein yield (Figs 1, 2). There was apparently no effect of N fertilization on the soybean oil yield of inoculated nodulating Clark and Harosoy in Experiment 1. Uninoculated nodulating and non-nodulating isolines showed an increase of 258% and 165% over the control in Clark and 29% and 84% over the control in Harosoy, respectively. Thus, the Clark isolines were more responsive to N rates than those of Harosoy. The nature of the response to N rates was quadratic in all the isolines except uninoculated nodulating Clark, which showed a linear

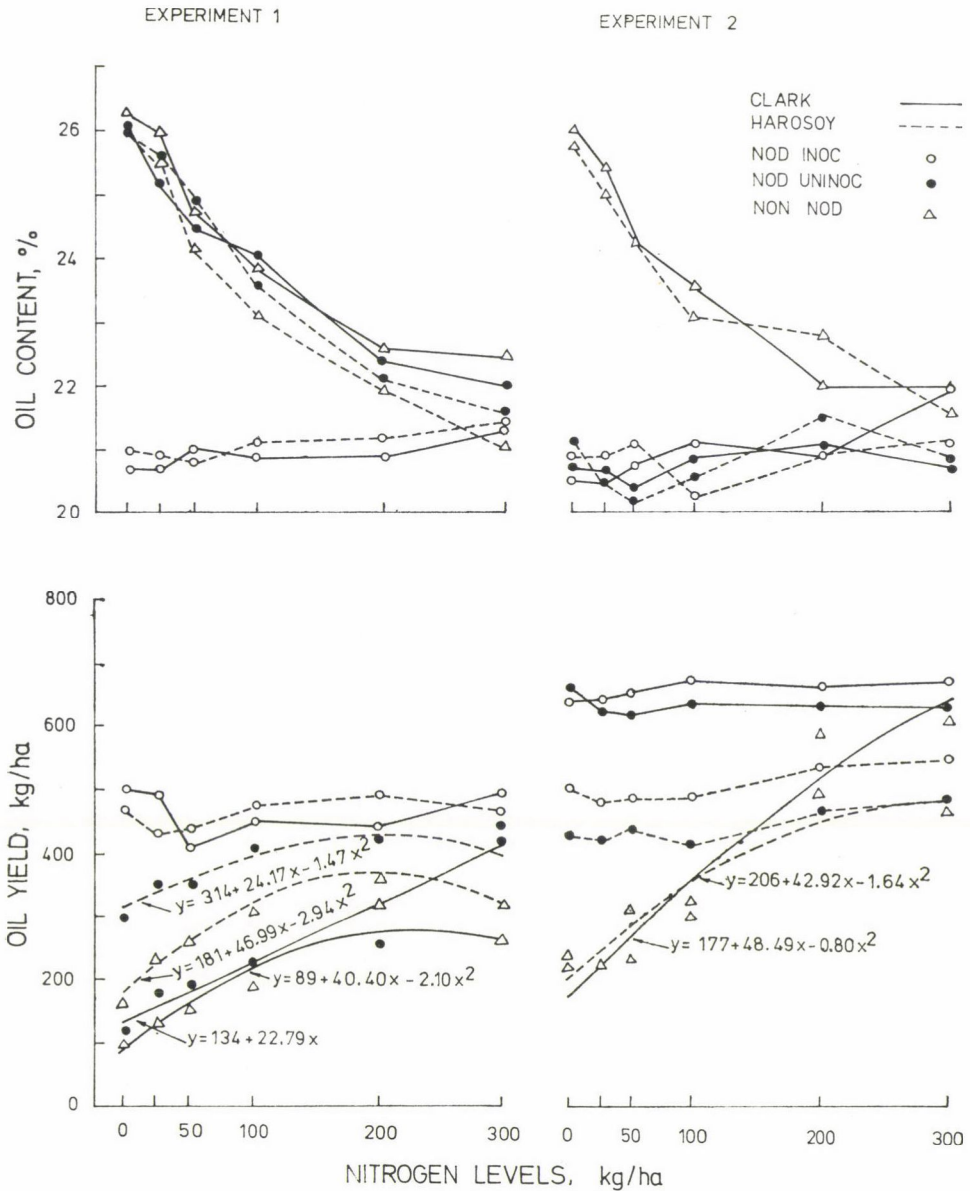


Fig. 2. Effect of N rates on oil content and oil yield of nodulating and non-nodulating soybeans. The response functions of N rates on oil yield were only fitted to those isolines that exhibited a significant response to N fertilization. One unit of 'X' equals 25 kg N/ha for the calculation of response equations

increase in oil yield even up to 300 kg N/ha. In Experiment 2, no effect of N application was observed on nodulating isolines (irrespective of inoculation) with both genetic backgrounds, as against a quadratic increase in the oil yield of non-nodulating isolines of Clark and Harosoy (Fig. 2). The maximum increases due to N application (300 kg N/ha) over the control were 182% and 110% in non-nodulating isolines of Clark and Harosoy, respectively.

An over-all comparison of crude protein and oil yields between different isolines with both Clark and Harosoy backgrounds revealed an interesting fact, namely, that nodulating isolines with effective nodulation always out-yielded those without effective nodulation (or because of the absence of a *Rhizobium japonicum* population), though the yield (crude protein and oil) differences were narrowed down considerably at the highest N level (300 kg N/ha). It should be mentioned that the inoculated nodulating isolines were well nodulated in both experiments, whereas the uninoculated nodulating isolines only had equally good nodulation in Experiment 2 (PAL—SAXENA 1975a, b). This was made possible owing to the presence of naturalized *Rhizobium japonicum* from previous soybean crops grown in the experimental plot in the past. It could, therefore, be said in summary that symbiotically fixed N proved better than fertilizer N for crude protein and oil production in soybean.

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THE TARSONEMID MITE (TARSONEMINA, HETEROSTIGMATA) UNDER CERTAIN FIELD CROPS IN THE MENOUIA GOVERNORATE, A.R.E.

The group *Tarsonemini* of the suborder *Trombidiformes* of the mites (*Acari*) was rather neglected for a long time, due partly to the minute size and partly to the rarity of the species, and it is only with the improvement of techniques and collecting methods that our knowledge of these animals has increased. In spite of the fact that considerable work has been done on the mite fauna of the A.R.E. (ABDEL-SHAHEED *et al.* 1971, ABDEL-TAWAB—METWALLY 1974) many aspects of the soil mites have still not been sufficiently investigated, especially the cohort *Tarsonemina*, which has been very poorly studied in Egypt.

Therefore, it was found necessary in the present work to make a survey of the different species of *Tarsonemid mite* and describe the seasonal variations in mite population density under certain field crops in the Shebin El-Kom district.

Collection of specimens. Mites were collected from soil samples which were taken periodically every two weeks with the aid of an iron sampler (10×10×10 cm) during the study period (Nov. 1977 to May 1978). The soil samples were collected from the surface layer (0—10 cm) under wheat, Egyptian clover and horse bean. The mites were carefully extracted

Table 1

Monthly changes in the population of soil *Tarsonemina* species (per m²) in a wheat field

Species	1977		1978				
	Nov.	Dec.	Jan.	Feb.	March	April	May
Fam. <i>Pygmephoridae</i>							
<i>Bakerdania centriger</i>	200	—	—	100	66	66	—
<i>B. gracilis</i>	100	—	50	—	100	66	—
<i>B. tarsalis</i>	—	200	50	3350	1270	343	500
<i>B. latipilosus</i>	—	—	—	—	—	166	—
<i>Bakerdania</i> sp.	—	—	—	—	—	100	—
Fam. <i>Pedeculasteridae</i>							
<i>Pedeculaster mesembrinae</i>	—	—	—	300	33	66	—
Fam. <i>Scutacaridae</i>							
<i>Scutacarus quadrangularis</i>	—	—	—	—	33	—	—
<i>S. suborbiculatus</i>	—	100	50	—	—	—	—
<i>Scutacarus</i> sp.	—	—	50	50	4000	1270	500
Fam. <i>Microdispidae</i>							
<i>Brennandania silvestris</i>	—	—	50	—	—	66	—
Fam. <i>Tarsonemidae</i>							
<i>Tarsonemus bilobatus</i>	—	—	—	—	33	66	400
Individuals (per m ²)	300	300	250	3800	5535	2209	1400
Total species	2	2	5	4	7	9	3

from the soil with the aid of Tullgren funnels. These mites were kept directly in 70% ethyl alcohol, mounted on slides and classified under a stereoscopic binocular microscope.

Slide preparations. Hoyer's modification of Berlese's mounting medium, as recommended by BAKER—WHARTON (1952), was used successfully to mount the mites. For permanent preparation the cover must be ringed to prevent the medium from coming out and to avoid the absorption of moisture. Altogether 120 slides were prepared, on which 609 individuals of the *Tarsonemid* mite were mounted.

In the soil under wheat, Egyptian clover and horse bean sixteen mite species of the cohort *Tarsonemina* were recorded, of which six species belong to the family *Pygmephoridae*, one species to each of the families *Pedeculasteridae* and *Siteroptidae*, three species to the fam. *Scutacaridae*, two species to the fam. *Microdispidae* and three species to the family *Tarsonemidae* (Tables 1, 2, 3).

It is possible to classify the *Tarsonemina* species which were recorded during the study period according to their feeding type in the following ecological groups:

Phytophagous mites: including most of the species which belong to the genera *Siteroptes* and *Tarsonemus*. These species not only cause damage as phytophages, but also play a role in transporting plant diseases (SUSKI 1973).

Fungivorous mites: represented by the species *Bakerdania centriger*, *Bakerdania tarsalis*, *Pedeculaster mesembrinae* and *Tarsonemus idaeus* (GURNEY—HUSEY 1967, SUSKI 1968 and WICHT 1970).

Saprophagous acari: In this group are included all the species which feed on dead organic matter as well as those feeding on the microflora; also those species on which there is no information in the literature so far as regards their feeding habits.

Table 2

Mean number (per m²) of soil Tarsonemina species in an Egyptian clover field

Species	1977		1978		
	Nov.	Dec.	Jan.	Feb.	March
Fam. Pygmephoridae					
<i>Bakerdania centriger</i>	—	100	200	100	66
<i>B. gracilis</i>	100	—	66	—	—
<i>B. tarsalis</i>	200	—	2000	100	200
<i>B. haarloevi</i>	—	—	66	—	—
Fam. Pediculasteridae					
<i>Pediculaster mesembrinae</i>	—	—	230	—	—
Fam. Siteroptidae					
<i>Siteroptes priscus</i>	—	—	166	—	—
Fam. Scutacaridae					
<i>Scutacarus quadrangularis</i>	—	—	100	—	—
<i>S. suborbiculatus</i>	—	—	66	500	66
<i>Scutacarus</i> sp.	—	—	133	—	66
Fam. Tarsonemidae					
<i>Tarsonemus idaeus</i>	—	—	66	100	—
Individuals per m ²	300	100	3093	800	398
Total species	3	1	10	4	4

The maximum number of different species of *Tarsonemina* observed was 9 species/2209 individuals per m² under wheat in April 1978, 10 species/3093 ind. per m² under clover in January and 8 species/6150 ind. per m² under horse bean in January (Tables 1, 2, 3).

There is no positive correlation between the number of individuals in the wheat field. Table 1 showed that in February 4 species were observed with a population density of 3800 ind. per m², but in April 9 species were recorded with a population density of 2209 ind. per m².

The species *Bakerdania tarsalis* was observed in maximum density under wheat in February (3350 ind./m²), *Bakerdania centriger* and *Bakerdania gracilis* in November (200, 100 ind./m² respectively) and *Scutacarus* sp. in March (4000 ind./m²; Table 1). Under clover *Bakerdania tarsalis* and *Bakerdania centriger* recorded their maximum population densities in January (2000 and 200 ind./m² respectively; Table 2). The density peak for *Bakerdania centriger* and *Brennandania silvestris* under horse bean was also observed in January (2100 and 2000 ind./m² respectively) while the maximum density for *Bakerdania gracilis* was recorded in December (1200 ind./m²; Table 3).

Rare species which were observed in a minimum population density under wheat were *Bakerdania latipilosus*, *Bakerdania* sp. and *Scutacarus suborbiculatus*, under clover *Pediculaster mesembrinae* and *Scutacarus suborbiculatus*, and under bean *Microdispus* sp., *Tarsonemus idaeus* and *Tarsonemus bilobatus*.

One *Tarsonemid* mite species was only recorded under wheat (*Bakerdania latipilosus*), a second was only observed under clover (*Bakerdania haarloevi*), and a third only existed under horse bean (*Microdispus* sp.). This proved that specific species of the *Tarsonemid* mite which prefer one host to the other live under certain field crops.

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Table 3

Monthly variations of soil *Tarsonemina* species (per m²) in a horse bean field

Species	1977		1978		
	Nov.	Dec.	Jan.	Feb.	March
Fam. <i>Pygmephoridae</i>					
<i>Bakerdania centriger</i>	550	100	2100	—	—
<i>B. gracilis</i>	400	1200	150	—	—
<i>B. tarsalis</i>	—	100	800	—	400
Fam. <i>Pediculasteridae</i>					
<i>Pediculaster mesembrinae</i>	50	400	700	—	500
Fam. <i>Scutacaridae</i>					
<i>Scutacarus suborbiculatus</i>	—	—	150	—	100
<i>Scutacarus</i> sp.	—	—	—	100	1100
Fam. <i>Microdispidae</i>					
<i>Brennandania silvestris</i>	—	700	2000	100	500
<i>Microdispus</i> sp.	—	—	50	—	—
Fam. <i>Tarsonemidae</i>					
<i>Tarsonemus bilobatus</i>	—	—	—	—	100
<i>Tarsonemus idaeus</i>	—	—	—	—	100
<i>Tarsonemus</i> sp.	—	—	200	—	—
Individuals per m ²	1000	1800	6150	200	2800
Total species	3	5	8	2	7

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MICROBIAL ECOLOGY OF THE MORPHACTIN-TREATED LEAVES OF CROTALARIA JUNCEA L.

The microbial colonization of leaves has received considerable attention since 1955. Various aspects of this have been studied, including the effects of various fungicides and chemicals (LAST 1955). The present paper is concerned with the microbial ecology of *Crotalaria juncea* (Sunnhemp) leaves sprayed with morphactin (chloroflurenol-methyl IT 3456). The principle objective of this study was to determine whether the morphological variations in the leaves produced as a result of the effect of morphactins also result in any change in the microbial population of the leaves.

The action of morphactin is systematic, resulting in a transient effect on various parts of the plants. *Crotalaria juncea* is a leguminous, simple, narrow, erect, shrubby, annual plant. This plant was chosen because of its great economic importance. It is one of the most commonly cultivated fibre crops in India. It is also used in green manuring and as a fodder.

The seeds were sown in a nursey bed in the year 1977. When the plants were 30 days old, morphactin in concentrations of 10^{-4} M, 10^{-5} M and 10^{-6} M was sprayed on the foliage. About 20 plants were used for each treatment. Triton X-114 (alkyl phenoxy-polyethoxy-ethanol) was used as a surfactant. Since the maximum morphological variation was observed in plants treated with the 10^{-4} M concentration, microbial studies were only carried out for that concentration. The plants were sprayed using a hand sprayer till the point of run-off.

Three techniques were used for the isolation of microbial flora on the leaf surface (SHARMA *et al.* 1974). The isolations were carried out after a week's interval.

1. Dilution plate technique. This method was used to determine the quantitative aspects of the microbial population. Colonies were counted after 7 days of incubation in culture plates containing Czapek-Dox's agar with rose-bengal. Various dilutions were tried but ultimately the 1/1000 dilution was found to be the best, so this was used for the inoculation.

2. Moist chamber technique. This was prepared by putting 2 to 4 blotters moistened with 10 ml of distilled water in a pair of petri dishes. This was autoclaved, then the leaves were incubated and studied after 10 day's incubation.

3. Impression technique. The leaves were pressed against Czapek-Dox's medium in petri dishes so as to leave an impression, then after 7 days of incubation the colonies were counted and identified.

The incubation of the plates in all three techniques was carried out at $27 \pm 1^\circ\text{C}$.

Significant morphological changes were observed after 7 days in plants treated with morphactin. The main attention was given to the microbial flora of the leaves, while the effect of morphactin on the plants themselves was not studied in depth. However, the significant changes can be summarized as follows:

1. The plants showed stunted growth due to the shortening of the internodal region.

2. There was a marked increase in the number of axillary branches. The number of axillary branches reached 10 to 12, while in the control there were not more than 4. At the same time the branches arose right from the base while in the control they were confined to the top after the formation of 7 or 8 nodes.

Table 1

Average total population of microbes using the dilution plate, moist chamber and impression techniques in 1977

15th October		23rd October		30th October		8th November	
C	T	C	T	C	T	C	T
3065.3	1419	1568.4	1520	8398.16	2767.3	8646.5	8719.5
15th November		23rd November		30th December			
C	T	C	T	C	T		
2593	798.8	5593.46	1554	465.2		191.8	

C = control T = treatment

3. The leaves became thick and dark with a dense chlorophyll content.

4. The leaves of the treated plants had a much reduced lamina. They became hairy and thickened, with different shapes. Some of the leaves became compound and some lobed. The total number of leaves increased remarkably.

5. The stem became more fleshy and hairy.

6. There was not much difference in the flower morphology and the yield of the plants.

Microbial population. No significant difference in the population of microbes was observed in the phyllosphere of the treated and control plants. However, in each of the experiments there was a decrease in the fungal flora of morphactin-treated leaves, though the percentage decrease varied in each of them because of seasonal variation too (Table 1).

During the present investigation no distinct qualitative difference was found between the microbial population of morphactin-treated and control leaves. RANGA RAO *et al.* (1972) did not find any noteworthy difference in the rhizosphere microflora of morphactin-treated and untreated plants either. *Aspergilli* were usually prominent in both the treated and control plants, but some of the fungi were dominant either in the control or in the treated plants only. In summary, no fungi were recorded which could be stated to be specific either to the treated or the untreated plants.

RAMACHANDRA (1968) and VENKATARAMAN (1960) reported that when plants were treated with urea there was a marked increase in the rhizosphere mycoflora. In the present study there was an overall quantitative decrease in the leaf mycoflora in treated plants, which may be due to the change in the leaf exudate pattern associated with the morphactin-treated plants.

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NITROGEN NUTRITION TO GREEN GRAM (PHASEOLUS AUREUS L.)

Legumes can meet their requirement by symbiotic fixation of atmospheric nitrogen, but on light soils the usefulness of nitrogen manuring is universally accepted for the maximum growth and development of leguminous plants (THIMMEGOWDA—KRISHNAMURTHY 1975, 1977). With this in view an investigation was initiated to explore a possible method of nitrogen nutrition to green gram.

A field trial was made during the kharif season of 1977 at Main Research Station, University of Agricultural Sciences, Bangalore, on red sandy loam soil having a normal fertility level (Table 1) under protective irrigation. The treatments included were: (a) no nitro-



Fig. 1. Nitrogen spray (3 kg/ha) at flower initiation (30 days from sowing)

gen, (b) nitrogen applied through foliage at flower initiation (3 kg/ha), (c) nitrogen applied through foliage at flower initiation (3 kg/ha) and pod development (3 kg/ha) and (d) nitrogen applied through soil (30 kg/ha) only. Foliar application of nitrogen was done at 0.4% concentration in the form of urea, while the soil application was at 30 kg per ha in the form of ammonium sulphate. All the phosphorus (60 kg per ha) and potash (20 kg per ha) were applied at seedling through the soil only in the form of single superphosphate and muriate of potash, respectively. The randomised block design was followed with five replications. The regular cultural operations were attended to. At the time of harvest ten plants in each plot were selected randomly for biometric observations.

The analysis of seed yield of green gram indicated that there was a significant difference due to the method of nitrogen application (Table 2). The maximum seed yield of 1820 kg per ha was obtained with the treatment which received the nitrogen through the soil only, followed by feeding the nitrogen through the foliage at flower initiation (1229 kg per ha), at flower initiation and pod development (987 kg per ha) and by no nitrogen application (885 kg per ha).

Table 1

*Physical and chemical properties of the soil
at the experimental site*

1. Coarse sand, %	44.00
2. Fine sand, %	29.50
3. Silt, %	2.00
4. Clay, %	16.12
5. pH	6.00
6. Organic carbon, %	0.29
7. C.E.C. in me/100 g	9.50
8. Exchangeable Ca in me/100 g	1.42
9. Exchangeable Mg in me/100 g	3.30
10. Exchangeable K in me/100 g	3.53
11. Free $\text{Ca}(\text{CO}_3)_2$, %	0.60

Table 2

Method of nitrogen application on yield and its components in green gram

Treatments	Seed yield, kg/ha	Seed weight/plant, g	Pod weight/plant, g	Number of pods/plant	Weight/pod, g	Pod length, cm	Seed weight/pod, g	Number of seeds/pod	1000 seed weight, g
1. No nitrogen	885	4.0	5.1	8.0	0.8	8.7	0.6	8.3	66.3
2. Nitrogen applied through foliage at flower initiation	1229	4.5	7.5	9.0	1.0	9.0	0.6	9.0	72.0
3. Nitrogen applied through foliage at flower initiation and pod development	987	4.3	6.7	8.3	1.1	9.0	0.6	9.0	75.7
4. Nitrogen applied through soil	1820	5.9	8.9	11.0	1.1	9.0	0.7	9.0	70.7
C.D. at 5%	145.00	0.50	0.45	0.63	—	—	—	—	4.53

The maximum seed yield with soil application of nitrogen as compared to foliar nutrition may be due to the fact that an adequate and balanced supply of nitrogen, phosphorus and potash in the soil had a favourable effect on nodulation, which in turn increased the pod and seed weights. PATE—DART (1961), working on nodulation studies in legumes, also reported the beneficial effect of nitrogen application through the soil in the growth and development of leguminous plants. Feeding nitrogen through the foliage at later growth stages as compared to soil application at seeding may not be effective in causing more pod formation and many of these pods remain immature at the time of harvest (Fig. 1). EMERY (1963) observed a loss of metabolites through the immature pods owing to the formation of gynophores in the groundnut crop.

The main feature of the treatment which recorded the maximum seed yield was higher pod weight per plant (5.9 to 8.9 g). This in turn was the consequence of an increase in the number of pods per plant (8 to 11), seed weight per plant (4.0 to 5.9 g) and seed weight per pod (0.6 to 0.7 g). The seed yield was highly associated with seed weight ($r = 0.898$), pod weight per plant ($r = 0.900$) and number of pods per plant ($r = 0.896$), while the 1000 seed weight showed a negative association ($r = -0.671$) with seed yield. However, components such as weight per pod (0.8 to 1.1 g), seed weight per pod (0.6 to 0.7 g), pod length (8.7 to 9.0 cm) and number of seeds per pod (8.3 to 9.0) did not make much contribution to seed yield.

Considering only the nitrogen-sprayed treatments, plants sprayed at flower initiation produced a maximum seed yield of 1229 kg per ha as compared to plants sprayed at flower initiation and pod development (987 kg per ha). Spraying during early crop growth stages, especially before flower initiation, would reduce the competition between vegetative and reproductive processes, creating better conditions for floral development and photosynthesis.

There was no significant difference between the treatment with no nitrogen applied (885 kg per ha) and the treatment when nitrogen was sprayed at the flower initiation and pod development stages (987 kg per ha), indicating that there is little importance in feeding nitrogen through the foliage to legumes at later growth stages.

Thus, the results revealed the importance of feeding nitrogen through the soil only to green gram for higher seed yield.

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COMPARATIVE ET STUDIES ON BERSEEM CLOVER GROWN AT DIFFERENT WATER TABLE DEPTHS

2. UNDER IRRIGATION CONDITIONS

In some regions, subsurface waters and a shallow water table can complement the irrigation need by providing water in the root zone for crop use (FOLLETT *et al.* 1974). Therefore, the first aim of this study was to investigate the effect of irrigation and non-irrigation on the evapotranspiration, growth rate and yield of Berseem clover (*Trifolium alexandrinum* L.) grown under different water table depths.

In recent years, considerable emphasis has been placed on the development of formulae for estimating evapotranspiration. These formulae vary widely in their sophistication but all are based on one or more meteorological variables. Many of the estimating formulae have either been derived or have been evaluated using the soil moisture conditions adequate for good plant growth and yield (JENSEN—HAISE 1963, HARGREAVES 1977b). Therefore, another objective of this study was to re-evaluate some ET formulae with measured data under different soil moisture conditions which are equal to or vary widely from those used in evaluating ET formulae.

The results have been drawn from an experiment described in an earlier paper (ABD EL-HAFEEZ 1979) and only an outline of the methods is given below.

18 lysimeters, 40 cm in diameter and 60 to 160 cm deep, were installed in two rows (2×9) in the same way as in the THORNTWHAITE—MATHER (1955) type of evapotranspirometer.

Three artificial water table depths were established in both lysimeter rows at 50 cm (I), 100 cm (II) and 150 cm (III) depth by maintaining the water at a height of 10 cm in the bottom of the lysimeter with simple regulating instruments installed in a measuring cellar. Two lysimeters from each water table level were covered at night and during each rainfall as shown in the earlier paper. One of them was left without irrigation throughout the season (I-2, II-2 and III-2), and the other was irrigated to keep it continuously at field capacity (I-3, II-3 and III-3).

Berseem clover (*Trifolium alexandrinum* L.) var. El mescawi was planted in lysimeters filled with sandy loam soil to represent the soil type of the surrounding area on May 6th 1976 and May 5th 1977. Three cuttings were taken on June 23rd, July 17th and October 1st 1976, and on June 24th, July 19th and October 2nd 1977, respectively.

The weather factors, evaporation and evapotranspiration were observed for 110 days in 1976 and 115 days in 1977 from June till September. Plant height was measured at 10-day intervals throughout each season. Green and air-dried yield was weighed for all lysimeters at every cutting. 6 evaporation and ET estimating formulae were re-evaluated using the data obtained. These formulae were: Jensen—Haise (JENSEN—HAISE 1963), modified Jensen—Haise (JENSEN *et al.* 1970), ANTAL (1968), HARGREAVES (1977a, b), PETRASOVITS (1970) and CHRISTIANSEN (1968). As mentioned by CHRISTIANSEN (1968), the actual ET can be determined with his formulae by using a crop factor such as that in HARGREAVES' (1968) tabulation (for more details see ABD EL-HAFEEZ 1979).

Data measured: The means of seasonal and daily values of evaporation and evapotranspiration for all water table depths and soil water regimes are shown in Table 1 and Fig. 1. The full period of measurement was 5 days shorter in the 1976 season due to the delay in establishing the experiment. Pan evaporation and precipitation are also listed in Table 1.

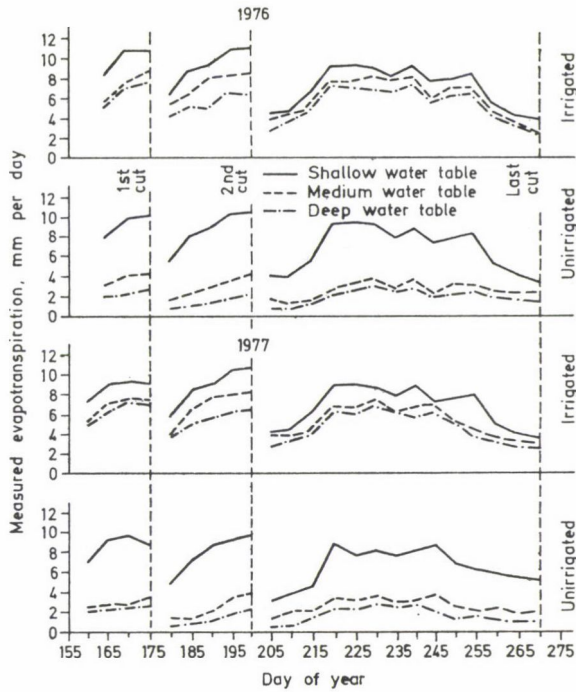


Fig. 1. Daily means of ET (average of 5-day period) of irrigated and unirrigated treatments at different water table depths

The differences in magnitude of the measured values under any treatment in the two seasons were attributed to the prevailing climatic conditions during each of the growing seasons.

Regarding the evapotranspiration, the data shown in Table 1 and Fig. 1 indicate a clear effect of water table depths and soil water regime on the amount and rate of Berseem clover evapotranspiration.

Table 1

Seasonal amounts and daily rate of evaporation, precipitation and ET for different treatments

Year	Period of measurement		Class A pan, mm	GGI pan, mm	Precipitation, mm	Measured ET					
						Shallow		Medium		Deep	
						I-2 un-irrig.	I-3 irrig.	II-2 un-irrig.	II-3 irrig.	III-2 un-irrig.	III-3 irrig.
1976	June 8th to Sept. 26th (110 days)	seasonal amount	452	432	222	791	822	265	652	167	560
		daily rate	4.1	3.9	2.0	7.2	7.5	2.4	5.9	1.5	5.1
1977	June 4th to Sept. 27th (115 days)	seasonal amount	467	467	146	805	835	287	643	185	566
		daily rate	4.1	4.1	1.3	7.0	7.3	2.4	5.6	1.6	4.9

With a shallow water table (50 cm deep), the ET of the irrigated and unirrigated treatments only showed very small differences, so the amount and rate of ET in the two seasons 1976 and 1977 is considered to be identical. These results were in agreement with those obtained by TOVEY (1969) and SZALÓKI (1974). It was noticed that the measured ET of plants grown in lysimeters with a shallow water table was much higher than the pan evaporation measured, which may be due to the vigorous plant growth caused by the nearness of the water table with aeration conditions assured by the water supply regulating instruments. It could also be due to the small surface area of the lysimeters (0.13 m^2) with the unnatural effect of their walls as indicated by HARGREAVES (1977a, b) and HARROLD (1966).

On the other hand, the medium (100 cm) and deep (150 cm) water table depths show a clear difference in ET between irrigated and unirrigated treatments. The irrigated treatments gave the highest value of ET, with a trend of decreasing ET as the water table depth increases. This may occur because it takes longer for adequate aeration conditions to be established in the root zone as the water table depth increases, which consequently has an effect on the plant growth and the ET rate. Conversely, plants grown in unirrigated treatments under medium and deep water table depths (II-2 and III-2) had the lowest seasonal amount and daily rate of ET over the two seasons of study. This may be due to the soil water deficit conditions in these treatments which have a strong effect on the number and growth rate of plants as compared with the irrigated treatments. BENNET *et al.* (1964) and DOSS *et al.* (1962) found that ET rates decreased at different soil moisture regimes as the amount of available water decreased.

In comparisons of growth rate (as indicated by plant height) and forage yield per cutting, as shown in Fig. 2, it was apparent that the shallow water table depth gave the highest growth rate and yield, while irrigation had no effect. The irrigation effect was strongly noticed, however, under medium and deep water table depths. This is in agreement with the results obtained by GILBERT—CHAMBLEE (1959), TOVEY (1969) and FOLLETT *et al.* (1974).

Estimating ET rates: Table 2 and Fig. 3 compare the monthly and seasonal estimated ET to that measured for irrigated and unirrigated treatments at three water table depths (50, 100 and 150 cm), and illustrate the magnitude of the differences between measured and estimated ET. None of the estimation methods reflects the measured ET rate for irrigated and unirrigated treatments with a shallow water table over the two seasons.

All the estimating methods underestimate the ET of irrigated and unirrigated treatments with a shallow water table by an average of 45%. This may be due to the vigorous growth of the plants, accompanied by a large leaf area, with a shallow water table, which may mean that they use more water than the other crops used in deriving or evaluating the

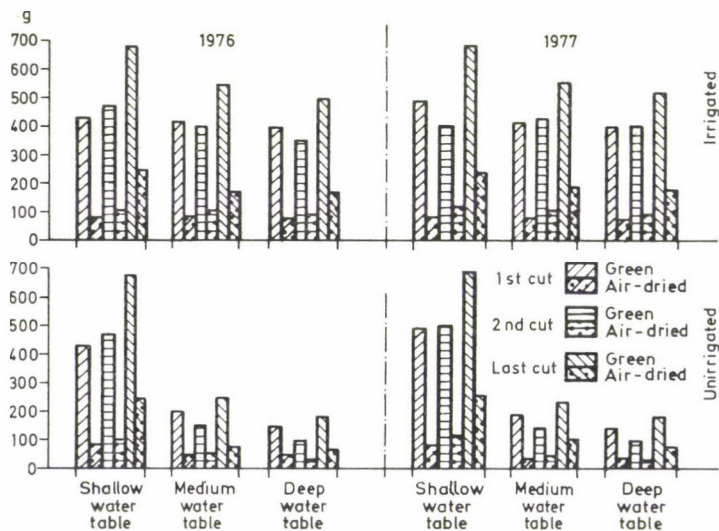


Fig. 2. Green and air-dried yield of irrigated and unirrigated treatments at different water table depths in 1976 and 1977 seasons

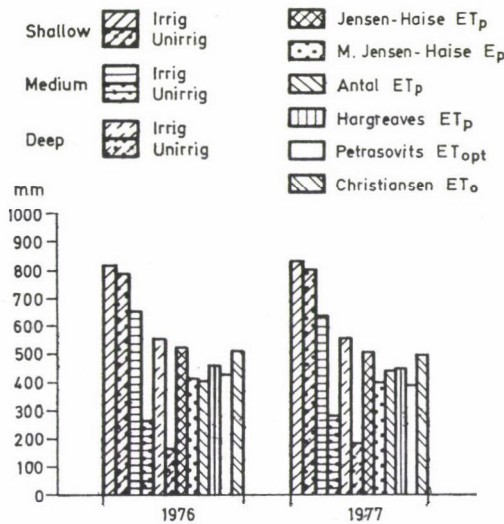


Fig. 3. Seasonal estimated and measured ET for irrigated and unirrigated treatments at different water table depths

estimation methods. Another possibility is that it is due to the small area of the lysimeters (0.13 m^2), combined with the unnatural effect of the lysimeter walls in ET as indicated by HARGREAVES (1977a, b) and HARROLD (1966).

As regards the medium and deep water table comparisons, it appeared that all the estimating methods underestimated the irrigated treatments (II-3 and III-3) by an average of 31 and 21% respectively. This may be due to the oasis effect, as indicated by ERDŐS (1967). Conversely, all the estimating methods overestimated the unirrigated treatments (II-2 and III-2) by an average of 61 and 153%, respectively. This may be due to the fact that ground-water alone at depths of 100 and 150 cm is not enough to maintain the soil water conditions and plant cover in an adequate condition, as assumed or used in deriving ET equations.

A study was made on the effect of irrigation and non-irrigation treatments under different water table levels on the ET, growth rate and yield of Berseem clover (*Trifolium alexandrinum* L.), with a comparative study of the ET estimated by some estimation formulae.

The maximum seasonal amount and daily rate of ET, growth rate and yield occurred with a shallow water table, with no response to irrigation. The unirrigated treatments showed the effect of water table depth on the ET and yield of Berseem. Plants grown under unirrigated treatment with medium and deep water tables had the lowest ET, growth rate and yield.

It is apparent that none of the estimating methods reflected the measured ET in shallow water table treatments or in irrigated treatments with medium and deep water table depths. On the other hand, all the estimating methods overestimate the measured ET of unirrigated treatments with medium and deep water table depths.

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Table 2
Comparison of measured and estimated evapotranspiration

Date	Measured ET					
	I-2	I-3	II-2	II-3	III-2	III-3
	shallow		medium		deep	
	unirrig.	irrig.	unirrig.	irrig.	unirrig.	irrig.
<i>1976</i>						
June 8th—30th	178	193	64	138	35	124
July	210	234	67	187	29	138
August	251	252	77	213	64	192
Sept. 1st—26th	141	143	56	114	39	106
Total season:	791	822	264	652	167	560
<i>1977</i>						
June 4th—30th	204	209	64	159	50	149
July	207	215	73	185	35	146
August	239	250	94	194	70	178
Sept. 1st—27th	155	162	57	105	30	93
Total season:	805	836	288	643	185	566
Average:	798	829	276	648	176	563
Date	Estimated					
	Jensen— Haise ET _p	Modified J. H. ET _p	Antal ET _p	Hargreaves ET _p	Petrasovits ET _{opt.}	Christiansen ET _a
<i>1976</i>						
June 8th—30th	153	120	133	130	162	165
July	173	135	136	145	135	172
August	117	94	96	106	85	105
Sept. 1st—26th	55	44	43	53	25	40
Total season:	498	393	408	434	407	482
<i>1977</i>						
June 4th—30th	144	113	129	121	118	141
July	159	125	129	140	124	175
August	141	111	115	124	105	125
Sept. 1st—27th	69	56	76	67	49	62
Total season:	513	405	449	452	395	503
Average:	506	399	429	443	402	493

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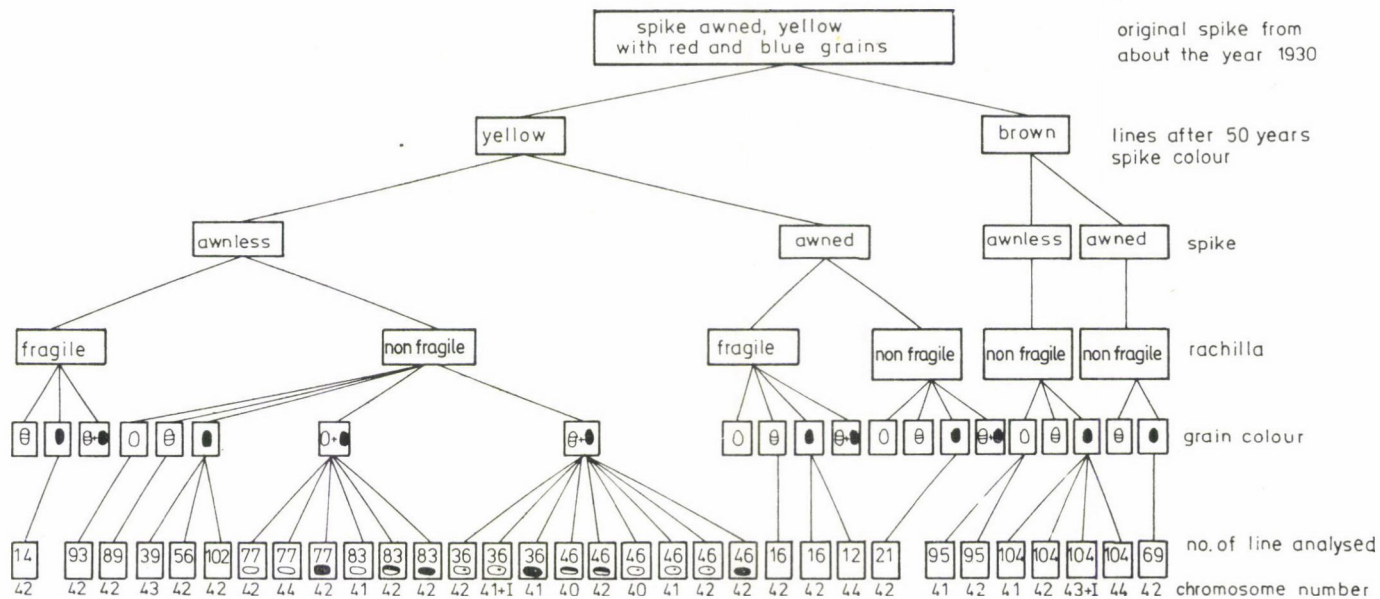
COLOURED WHEAT FROM THE EFFECTS OF E. TSCHERMAK

This is a review of the morphological characteristics and atypical segregation in grain colour and ear characteristics within lines and plants of winter wheat from the effects of E. Tschermak. Four new botanical varieties of winter wheat are described.

Origin of the material

In the year 1930 Dr K. Mostovoj, a researcher at the then Provincial Research Institute in Brno, was given several grains of winter wheat of unknown origin by Prof. E. Tschermak. Among the individuals produced from these grains, which had strikingly unusual blue grains, there occurred a plant with an ear containing grains of two colours, some of them blue, like the grains which were sown, and the remainder red. All the remaining spikes had blue grains only.

The ear containing both blue and red grains was yellow, awned, and had a non-fragile rachis (*Triticum aestivum* L.). Later an extensive collection of about 200 lines of winter wheat arose from the grains of this one spike, through gradual and repeated segregation. The segregation produced various types of plant (tall, short), and various types of ear (from lax to dense, and including spikes of the type *Triticum spelta* L.), including yellow ones, brown ones, awned and awnless. Grain colour also segregated into three basic colours in one spike.



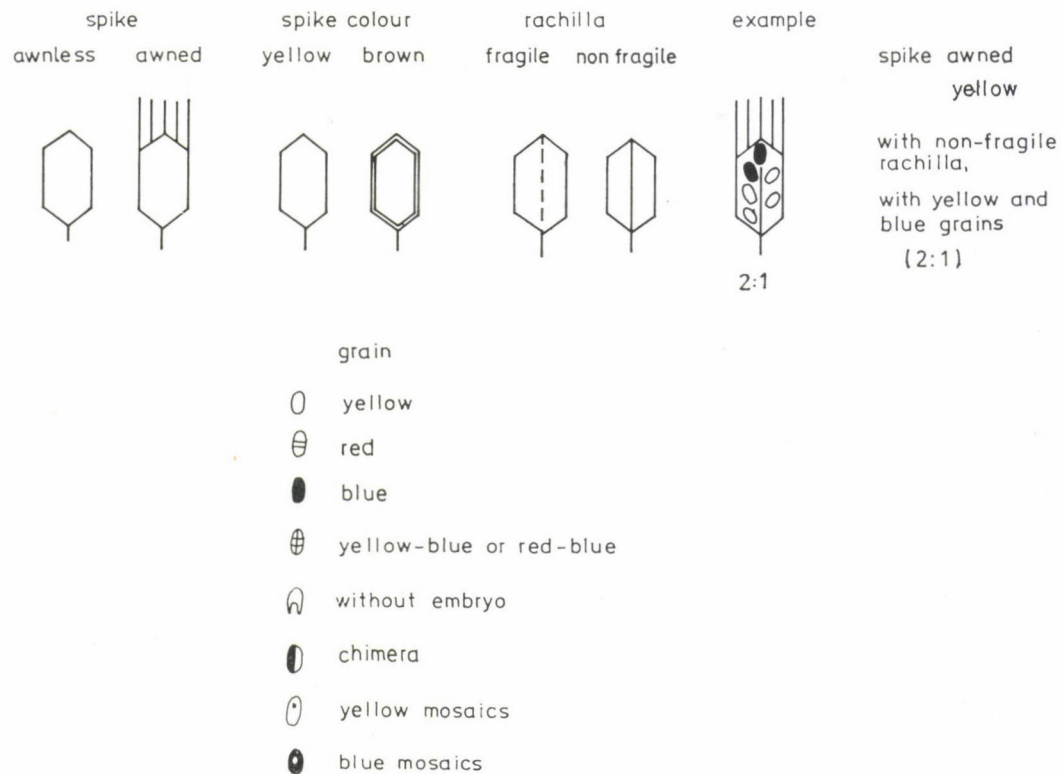


Fig. 1. The structure of lines of "coloured" wheat

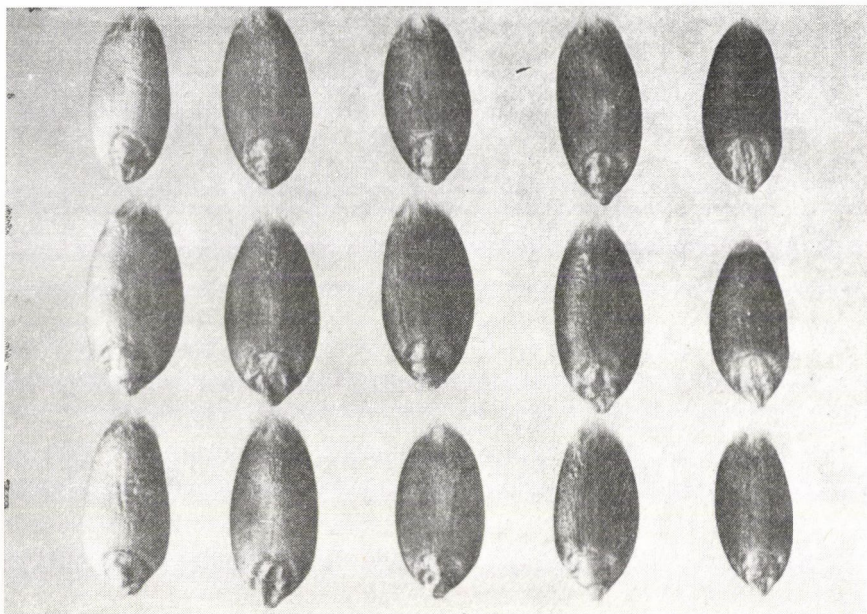


Fig. 2. 5 selected shade of grain colour from "coloured" wheat (Column 1 — yellow; Column 2 — yellow-red; Column 3 — red; Column 4 — red-blue; Column 5 — blue)

Dr. Mostovoj kept this genetical collection, which he called "coloured" wheat, until 1972, when he handed the entire material over to one of the authors of this article at the Institute of Genetics and Plant Breeding at Ruzyně, near Prague. The collection contained 160 lines, whose morphological characteristics of colour, spike character and grain character are shown in Fig. 1. Almost all lines had ears with several grain colours. These were mostly yellow and blue or red and blue, sometimes with intermediate colours (Fig. 2). Those lines in Fig. 1 which bear reference numbers were subjected to cytological analysis. This "coloured" wheat was studied for seven years, and the results are presented here.

Hypotheses relating to the origin of "coloured" wheat

The origin of the "coloured" wheat, which, even after 50 years of selection for certain morphological characteristics, still segregates in some lines, particularly in grain colour, cannot today be reliably established. According to Mostovoj, it is probably an intergeneric hybrid between *Triticum aestivum* L. and *Aegilops ovata* L. This view was certainly influenced by the works of PERCIVAL (1930) and TSCHERMAK (1914), by which Mostovoj set great store. It cannot be, however, excluded that the material is from other sources. For example, KATTERMANN (1932a, b) describes in his work crosses between speltoid forms of wheat and *Aegilops ovata*, which he made in 1923. He mentions that he also worked on crosses with the rye *Secale montanum* and in the course of this obtained various coloured grains. TSCHERMAK (1933) also mentions not only intergeneric crosses between various species of *Triticum* and *Aegilops*, but also hybrids with rye.

The inheritance in wheat of a blue endosperm colour derived from *Agropyron elongatum* Host Beauv. was studied by KNOTT (1958)). The gene(s) for blue endosperm was found to be carried on an *Agropyron* chromosome which is not homologous to a wheat chromosome.

Morphological description and systematic classification of lines

The "coloured" wheat material which is currently at our disposal includes non-segregating lines, which can be attributed to the documented varieties *Triticum spelta* (2 lines) and *Triticum aestivum* (8 lines), including the four botanical varieties not yet described. These are as follows:

- T. spelta* L. var. *albispicatum* Flaksb.
- T. spelta* L. var. *arduini* Mazz.
- T. aestivum* L. var. *aureum* Link.
- T. aestivum* L. var. *lutescens* Alef.
- T. aestivum* L. var. *greacum* Körn.
- T. aestivum* L. var. *erythrospermum* Körn.
- T. aestivum* L. var. *tschermakianum* Msf.
- T. aestivum* L. var. *alborubrum* Körn.
- T. aestivum* L. var. *milturum* Alef.
- T. aestivum* L. var. *ferrugineum* Alef.

New botanical varieties are:

- T. spelta* L. var. *mostovoy* Škorpík (var. nova)
 - yellow, lax spike with fragile rachis
 - awnless lemma
 - glabrous, normal glume
 - base of spikelet with tufted hair
 - blue grain
- T. spelta* L. var. *cyanospermum* Škorpík (var. nova)
 - yellow, lax spike with fragile rachis
 - awned lemma
 - glabrous, normal glume
 - base of spikelet with slightly tufted hair
 - blue grain
- T. aestivum* L. var. *rodianum* Škorpík (var. nova)
 - yellow, lax spike with non-fragile rachis
 - awnless lemma
 - glabrous, normal glume
 - hairy edges of rachilla
 - blue grain
- T. aestivum* L. var. *kovacicianum* Škorpík (var. nova)
 - brown, lax spike with non-fragile rachis
 - awnless lemma
 - bare, normal glume
 - base of spikelet with tufted hair
 - hairy edges of rachilla
 - blue grain

The blue colour of the grains is formed in the aleuron layer of the endosperm.

Grain colour and its heredity

The 160 lines studied were divided according to the intensity of segregation into non-segregating, occasionally segregating (after several reproductions) and permanently segregating, i.e. in every generation (examples are given in Figs 3, 4). The non-segregating lines were described above.

Variously coloured grains (yellow and blue or red and blue) from the same ear from permanently segregating lines were sown separately. The yellow and red grains segregated continually, while the blue mostly produced offspring with blue grains (Figs 3, 4). At the same time the hypothesis that grains of a particular colour, especially blue, might appear on the left or the right hand side of the ear or at the top or the bottom was also tested. No evidence of this was found. The blue grains in dual-coloured ears, whether *spelta* or *aestivum*, are completely irregularly located in the ear, and absolutely at random. This is stated on the basis of several hundred analyses.

In all lines segregating annually the segregation relations of grain colour were studied. The segregation relations between yellow and blue grains and between red and blue grains range from 1 : 1 to 30 : 1, or vice versa; in exceptional cases even 1 : 100. Intermediate grain colours also occur, as indicated in the figures. Practically every ear of the same line has a different segregation relation and no pattern was found in this area during the whole study. As has been mentioned, only the offspring of blue grains from some lines segregate to a limited extent or not at all.

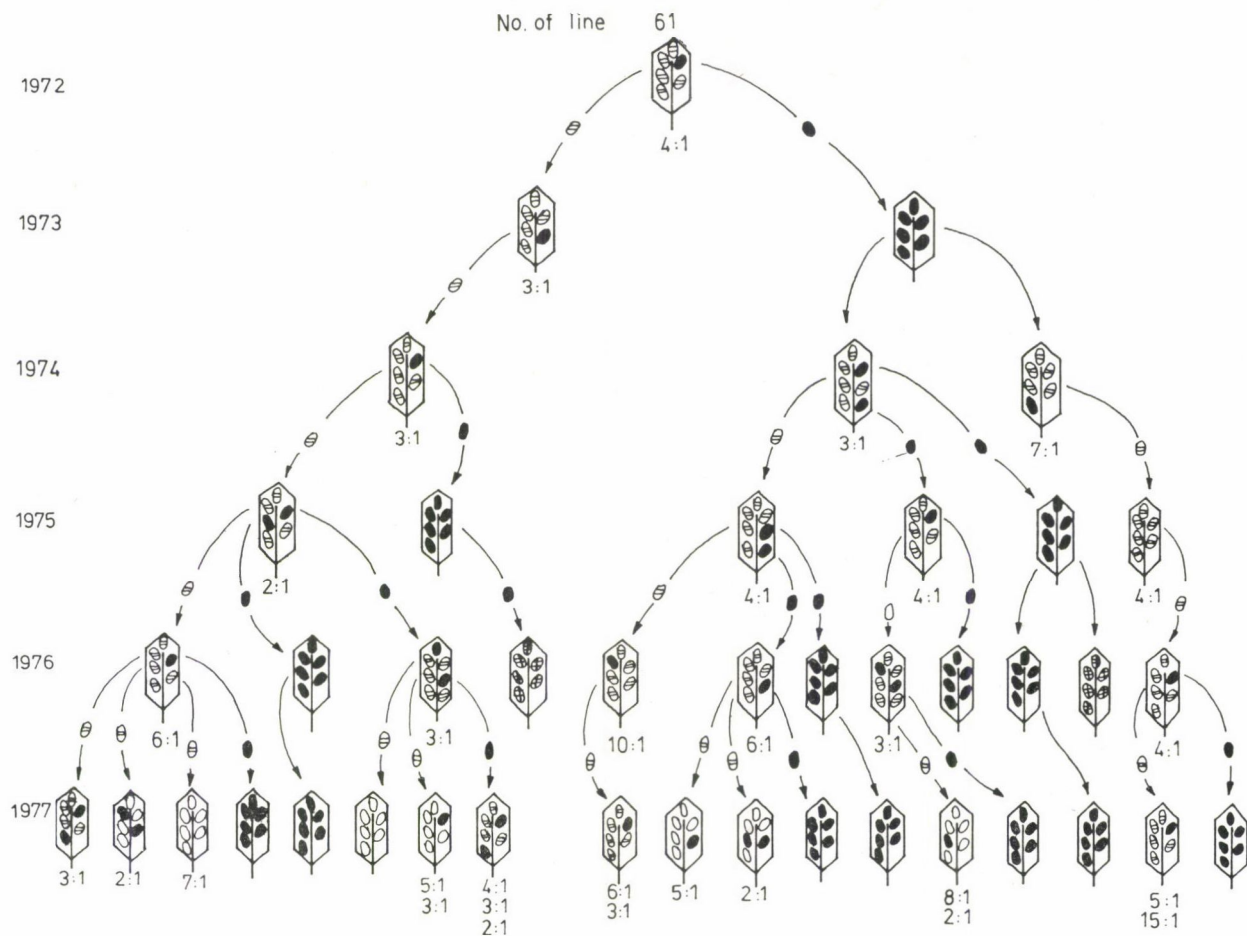


Fig. 3. Example of line with regularly repeated segregation of grain colour (For Key, see Fig. 1)

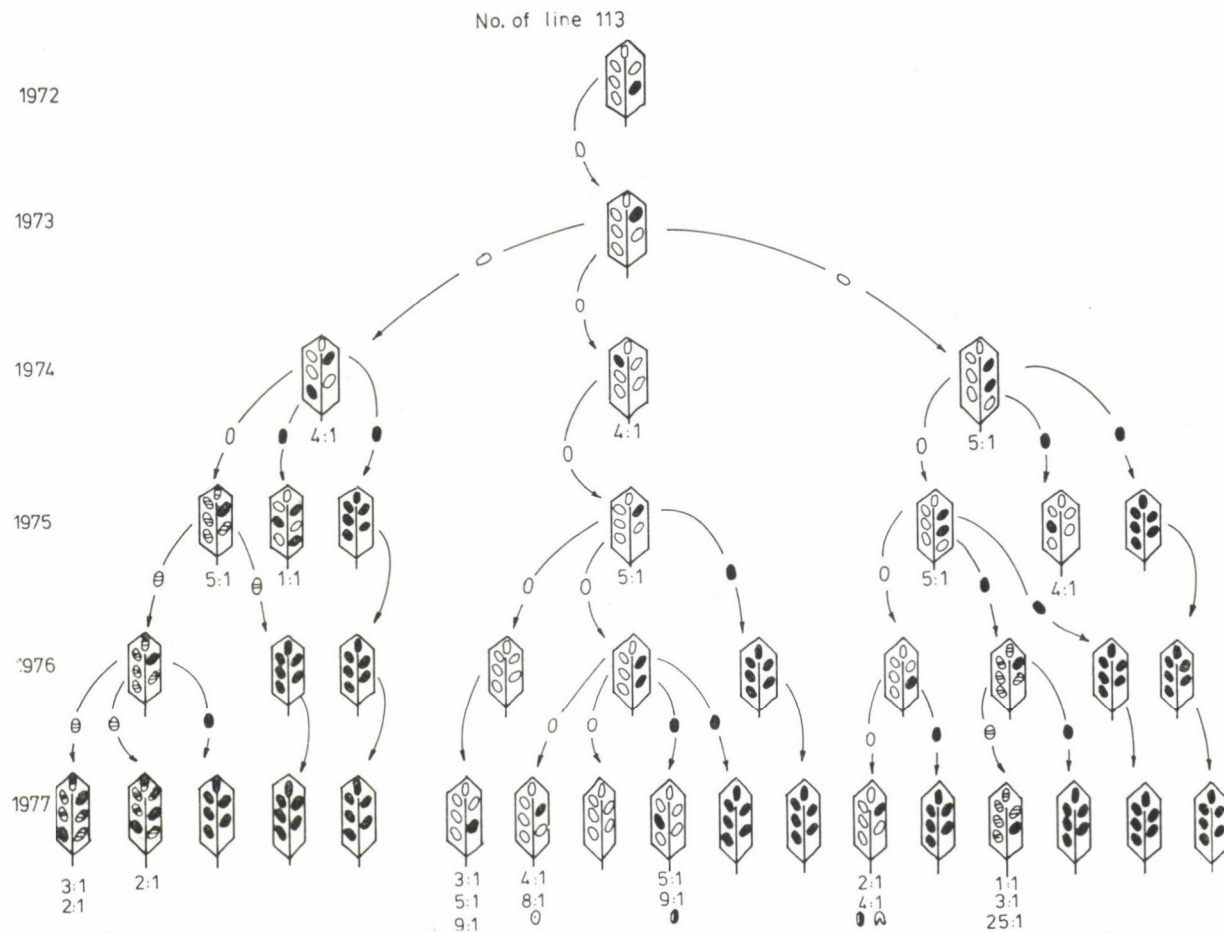


Fig. 4. Example of line with regularly repeated segregation of grain colour (For Key, see Fig. 1)

Study of some quantitative traits

Three quantitative traits which condition yield in the lines under consideration were studied:

- a) Grain weight/ear. The weight in grams of the seeds per ear.
- b) Kernels/ear. Number of seeds per ear.
- c) Kernel weight. Average weight in milligrams of one kernel.

Of the large amount of material available only the results from 1977 will be presented here, i.e. from an experiment in which the progeny was studied in individually laid out nurseries with a spacing of 20×5 cm (Table 1).

Table 1
Quantitative traits of spikes with variously coloured grains

Classification of lines	Quantitative traits	Lines with max. trait level				Lines with min. trait level			
		yellow	red	blue	$\frac{y+b}{r+b}$	yellow	red	blue	$\frac{y+b}{r+b}$
<i>Triticum aestivum</i> L.	grain weight/ear (g)	2.5	3.6	2.7	2.7	0.2	0.4	0.4	0.5
	kernels/ear	50	74	61	58	10	12	15	14
	kernel weight (mg)	55	55	57	69	27	33	19	23
<i>Triticum spelta</i> L.	grain weight/ear (g)	—	2.7	2.3	1.7	—	0.6	1.0	0.9
	kernels/ear	—	56	37	39	—	14	24	30
	kernel weight (mg)	—	59	59	61	—	33	38	38

As can be seen from Table 1, there exist lines with a very good level of quantitative traits in the case of all grain colours. The minimum values given in the right half of the Table are influenced by spike sterility, which is of genetic origin and will be dealt with later.

Spikes

In order to exclude the possibility of dual grain colour in the spike being caused by open pollination, the spikes of several dual-coloured lines were repeatedly isolated before flowering. The distribution of grain colour in the isolated spikes was determined and compared with that of non-isolated ones. There was no difference at all between the two groups, the two grain colours in the isolated spikes being just as irregularly and randomly distributed as with the non-isolated spikes. The existence of dual grain colour in the isolated spikes gave evidence that the second grain colour in a spike does not arise through open pollination.

The sterility of spikes and grains, and other peculiarities

With some lines of "coloured" wheat, particularly in lines with two grain colours in one spike, a high degree of spike sterility was observed, as high as 90% in some plants (Fig. 5). There were isolated cases of plants with 100% sterility, which sometimes died either before or after heading. This lethality is attributed to an irregular number of chromosomes and their irregular pairing.

Predominantly in lines with irregular chromosome number and pairing, grains with an undeveloped embryo were also observed (Fig. 6), which were, of course, incapable of reproduction.

In these defective lines, and exceptionally also in other lines, grains were found which were divided by a longitudinal groove into yellow and blue or red and blue halves (Fig. 7), so-called "chimeras". Grains with patches of a second colour also occur. Yellow grains with blue patches were designated yellow mosaics, and blue with yellow or red patches, blue mosaics.



Fig. 5. Sterile spikes occurring in many lines

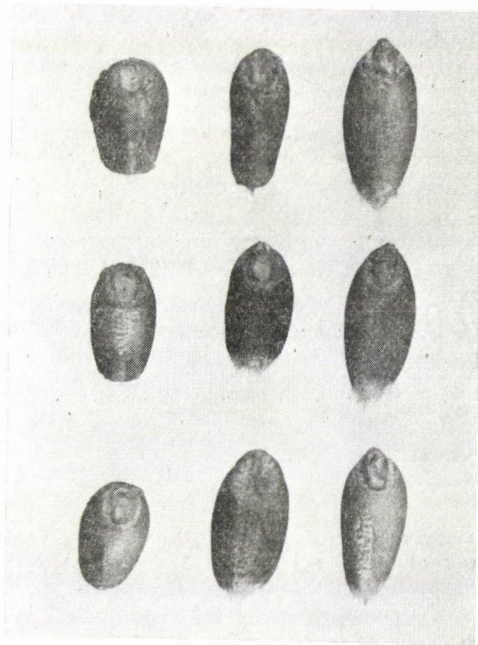


Fig. 6. Normally developed grains (col. 1) and grains without embryos (columns 2 and 3)

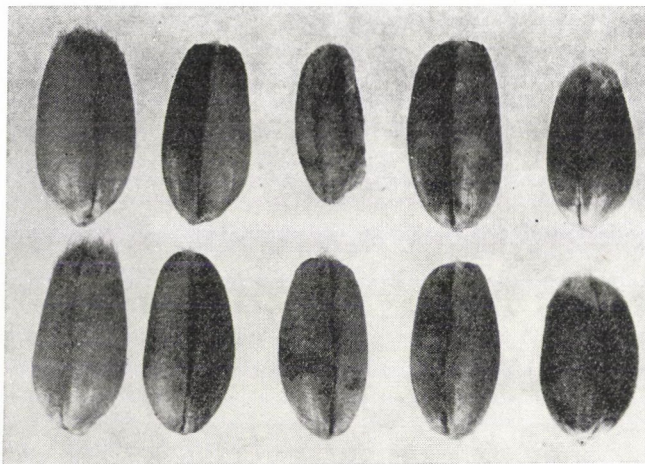


Fig. 7. Chimeras and mosaics (Col. 1 — normal grains, yellow colour; Col. 2 — chimeras; Col. 3 — mosaics, blue patches on yellow; Col. 4 — mosaics, yellow patches on blue; Col. 5 — normal blue grains)

The determination of chromosome number

A representative population of lines was selected so as to include at least one of each type of spike (brown — yellow, awned — awnless, fragile — non-fragile) and grain colour (yellow, red, blue). The chromosome number was ascertained in the root-tips of these varieties. The vast majority of lines had the normal chromosome number, 42. With some lines the chromosome number varied from 40 to 44. The grain of chimeras and mosaics had particularly deviant chromosome numbers (see Fig. 1).

The grains of individuals with an atypical number of chromosomes were sown individually and the progeny of chimeras and mosaics showed high lethality; in some cases they set a spike but remained sterile.

Overall evaluation of the material

The population of winter wheat lines described above represents genetically unstable material, showing a high degree of genetic mutability, especially in the morphological characteristics of the grain. The use of lines for further genetic studies, or for selection programmes or combinational hybridization can be considered a feasible proposition.

Crosses have also been carried out between normal and blue lines so as to study the inheritance of certain characteristics. Some of the lines obtained from a cross between "Coloured 12" (*Triticum spelta* var. *mostovoy* Škorpík) and the variety "Belozernaja" (*Triticum aestivum* var. *alborubrum* Körn) were found to be resistant to cereal rusts in connection with the presence of glyadine zone Gld 1B 3. A further paper (BARTOS *et al.* 1980) is devoted to the results of this work.

It should be added that the authors are willing to put the above material at the disposal of anyone with a serious interest in its further study or practical use.

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ANALYSIS OF THE INFLUENCE OF NITROGEN FERTILIZATION ON THE PROTEOLYTIC ACTIVITY OF CERTAIN SOILS

The proteolytic enzymes are known to hydrolyse peptases and the protein components of the organic matter (KUPREVICH—SHCHERBAKOVA 1966), on account of which they play an important part in the dynamics of nitrogen in the soil (KHIZIEV *et al.* 1972).

The proteolytic activity depends on the physicochemical properties of the soil (VAVULO 1978, VLADIMIROVA—KARNIENKO 1972, KUPREVICH—SHCHERBAKOVA 1966) and on the applied agrotechnical measures.

Fertilization exerts a considerable influence too (YERSHEV 1972, RANKOV—DIMITROV 1977, RANKOV 1978). This is explained by the fact that under intensive agricultural conditions crops are fertilized with comparatively high rates of fertilizers per unit area.

The effect of mineral and organomineral fertilizers on the proteolytic activity of the soil has been studied in many years of experiments and laboratory tests (RANKOV—DIMITROV 1974, 1977, RANKOV *et al.* 1977, RANKOV 1978). Some of these investigations are presented in this paper.

Under coktrolled conditions, with a temperature of 22—25°C and a soil humidity of 60—65% of the maximum water-holding capacity, the effect of nitrogen fertilizer application with ammonium sulphate, sodium nitrate, ammonium nitrate and carbamide has been studied on the proteolytic activity of soils with different physicochemical properties: leached chernozem, leached chernozem-smolnitza, leached meadow-cinnamonic and alluvial-meadow soil. The rates of 120, 240, 360, 480 and 600 kg N/ha were tested in the course of 90 days after fertilizer application in the soil. The experiment was carried out with a basic fertilization of $P_{240}K_{240}$, expressed as active substance of P_2O_5 and K_2O per hectare. Double superphosphate and potassium sulphate were used.

Table 1

Results of agrochemical analyses of the soils included in the investigation

Soil	in mg/100 g soil			pH in water extract	Humus, %
	$\begin{matrix} NH_4-N \\ NO_3-N \end{matrix}$	P_2O_5	K_2O		
Leached chernozem	2.0	29.5	11.9	7.1	2.9
Leached chernozem-smolnitza	4.6	45.0	34.7	7.6	3.0
Leached meadow-cinnamonic	2.9	36.0	29.8	7.1	2.2
Alluvial-meadow	3.2	24.0	18.0	7.2	1.6

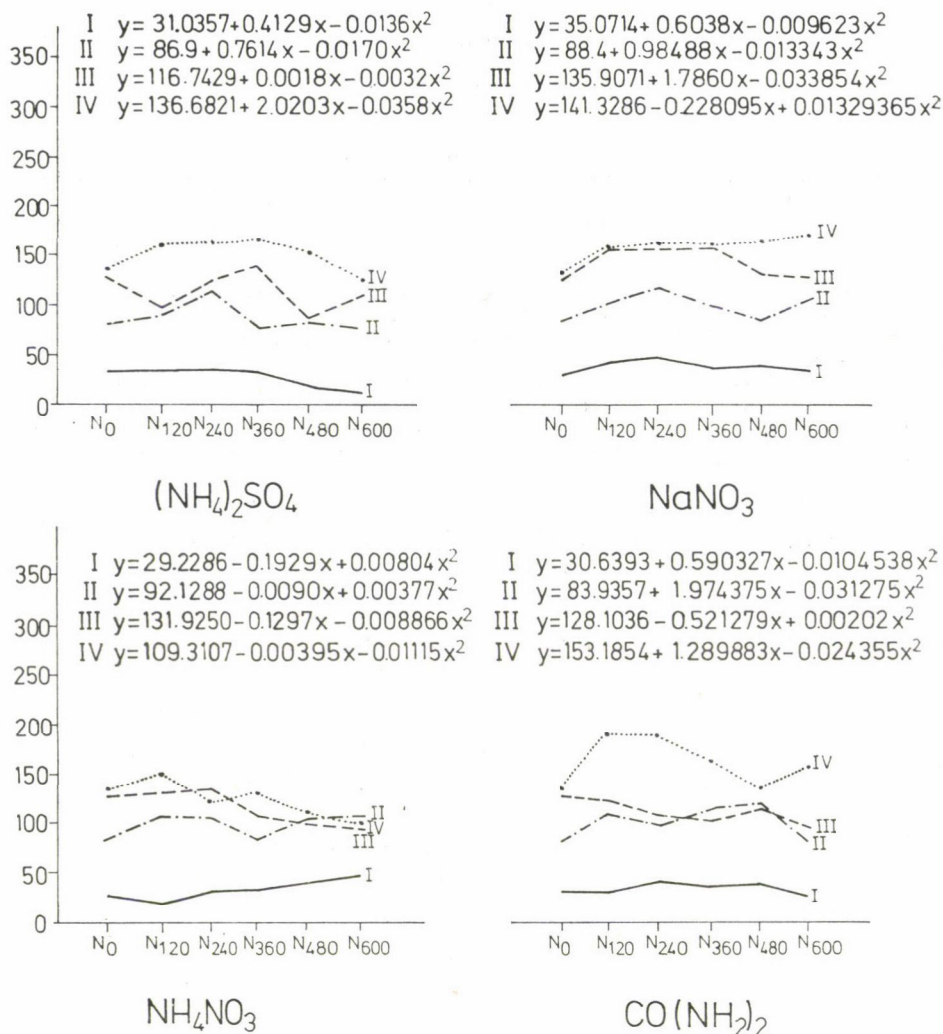


Fig. 1. Effect of nitrogen fertilization on the proteolytic activity of the soil (in gelatin-like units of 10 g soil). (I — leached chernozem; II — leached chernozem-smolnitza; III — leached meadow-cinnamonic; IV — alluvial-meadow soil)

The fertilizer rates used (NPK) were taken from those used in practice or those tested for their effect on the productivity and quality of the vegetable crops grown in Bulgaria (DIMITROV *et al.* 1976).

The results of the agrochemical analysis of the soils studied are given in Table 1. The highest resources of mineral nitrogen ($\text{NH}_4 + \text{NO}_3$), mobile P_2O_5 , K_2O and humus content were found in the leached chernozem-smolnitza followed by the leached meadow-cinnamonic soil. Their reaction is slightly alkaline (pH from 7.1 to 7.6).

The agrochemical analyses were made using the following methods: mineral nitrogen (ammonium and nitrate) by distillation; mobile P_2O_5 and K_2O after Egner—Rhiem; pH with a potentiometer in water extract; humus after Tyurin, and the proteolytic activity after the method of ROMEIKO (1969), expressed in gelatin-like units per 10 g of soil.

The results show that the nitrogen fertilizers used have different effects on the proteolytic activity of the soils included in the investigation. The changes which take place are shown in the equations and regressive straight lines in Fig. 1.

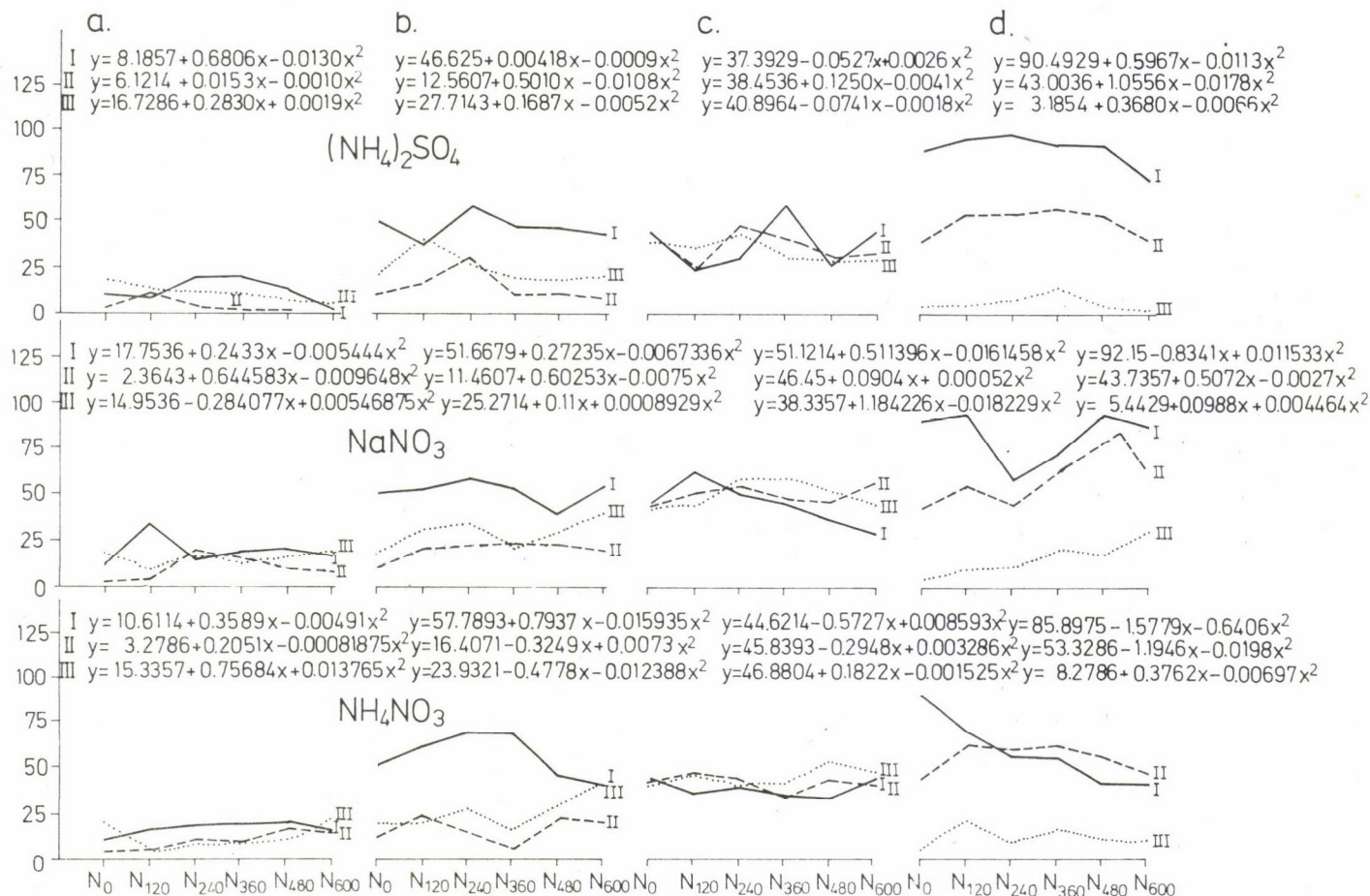


Fig. 2. Changes in the proteolytic activity of the soil according to the terms of nitrogen application (in gelatin-like units of 10 g soil). (a — leached chernozem; b — leached chernozem-smolnitza; c — leached meadow-cinnamonic soil; d — alluvial-meadow soil; I — on the 30th day; II — on the 60th day; III — on the 90th day)

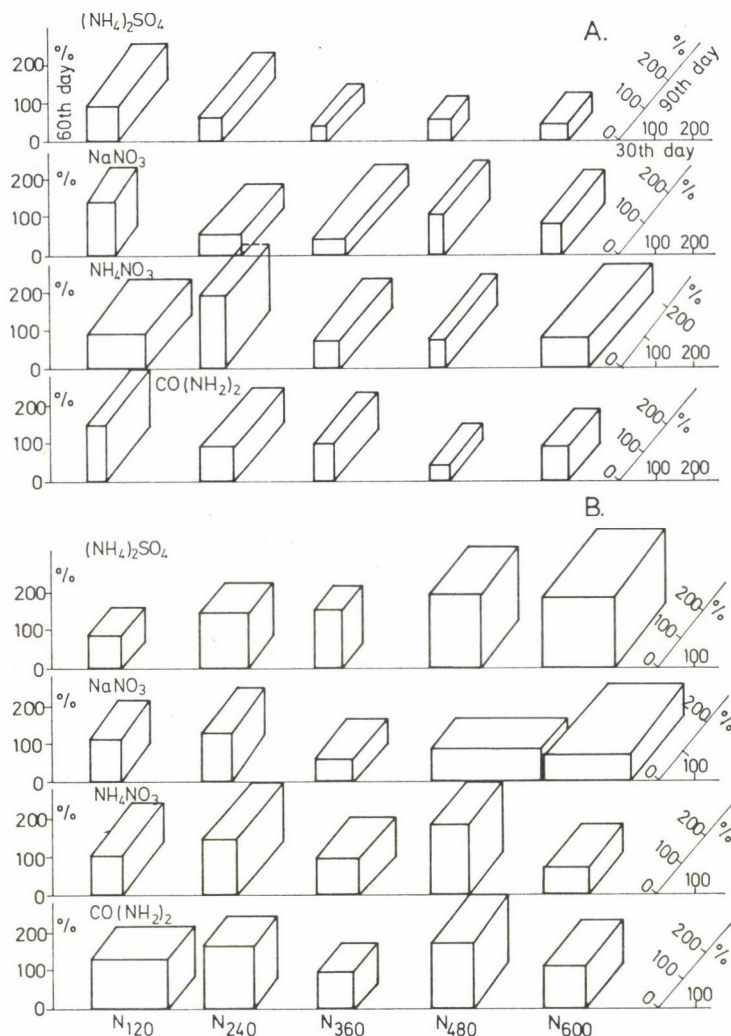


Fig. 3. Effect of nitrogen fertilization on the development of the ammonification bacteria (as % compared to the non-fertilized control). (A — leached chernozem; B — alluvial-meadow soil)

Marked changes in the intensity of the proteolytic activity were observed with the increased ammonium sulphate rate, while with sodium nitrate only slight changes occurred. The intensity of enzyme activity decreased when ammonium sulphate was applied at rates higher than 360 kg N/ha in leached chernozem, meadow-cinnamonic and alluvial-meadow soil.

The tested rates of sodium nitrate did not cause any changes in the proteolytic activity of leached chernozem and meadow-cinnamonic soils, but increased the activity in the leached chernozem-smolnitza and the alluvial-meadow soil.

At doses of up to 240 kg N/ha carbamide enhanced the enzyme activity in leached chernozem and alluvial-meadow soil and up to 480 kg N in chernozem-smolnitza soil.

The investigations of KONOVALOV (1966), conducted with different strains of micro-organisms, show that when the nitrogen source was sodium nitrate there was a medium increase in the development of proteolytic enzymes in most of the bacteria, actinomycetes

and microscopic fungi, while with ammonium nitrogen applied as ammonium chloride or ammonium sulphate it decreased considerably.

Ammonium sulphate decreased the activity more intensively on the 60th day of fertilizer application in leached chernozem and chernozem-smolnitza and on the 30th day in alluvial-meadow soil (Fig. 2). Ammonium nitrate decreased the intensity of the proteolytic activity up to the 30th day in leached chernozem-smolnitza and in alluvial-meadow soil.

The application of sodium nitrate at rates higher than 240 kg N/ha reduced the enzyme activity on the 30th day only in leached meadow-cinnamonic soil, while from the 60th to 90th day all the rates tested increased the activity in leached chernozem-smolnitza, meadow-cinnamonic and alluvial-meadow soil.

The effect of the different nitrogen sources on the development of the ammonification bacteria is similar (Fig. 3). Greater changes in their development take place due to the effect of ammonium sulphate and ammonium nitrate. These changes are more markedly expressed in alluvial-meadow soil than in leached chernozem and chernozem-smolnitza.

A stimulating effect was observed when sodium nitrate and carbamide was used on the 60th and 90th day after the fertilization. This is also more apparent in alluvial-meadow soil.

A correlation in nitrogen sources, terms and soils between the proteolytic activity and the development of the ammonification bacteria was not established.

The greater effect of the nitrogen fertilization on the proteolytic activity and on the development of ammonification bacteria under the conditions of alluvial-meadow soil than under those of leached chernozem and chernozem-smolnitza is explained by the physico-chemical properties. Alluvial-meadow soil has a light mechanic texture (sandy-loam) and has the lowest humus content comparatively.

Greater changes in the intensity of proteolytic activity after application of ammonium sulphate and ammonium nitrate have been established but they are smaller when sodium nitrate is used. This is more markedly expressed in alluvial-meadow soil and is weaker in leached chernozem and chernozem-smolnitza.

The effect of the different nitrogen fertilizers on the development of ammonification bacteria is similar.

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INFLUENCE OF SEED SIZE ON SOYA BEAN PERFORMANCE

In many crops, seed size has been recognized as a factor in seedling vigour and subsequent plant performance by several workers (AHMED—ZUBERI 1973, BLACK 1957, EL-SAEED 1967, KAUFMAN—MACFADDEN 1963, PINTHUS—OSHER 1966, TONDON—GULATI 1966). The studies by these workers clearly indicated that the more vigorous seedlings given by larger seeds continued to produce more vigorous plants as the season progressed, resulting in increased final yield. Soya bean is normally planted with almost completely ungraded seeds. However, the potentiality for increased yield as reported in other crops justifies similar studies in soya bean, especially in view of the relative ease of grading its seeds. The present investigation was therefore undertaken to determine the influence of seed size on the performance of soya bean.

Three soya bean varieties, SRF 425, EC 11780 and SJ 2, were used in the present study. Two lots of seeds, large and small, were obtained by hand selection from the bulk sample of each variety. These seeds were grown in a split-plot design with varieties in the main plot and seed size in the subplots. Seed size treatments were a) small, b) large and c) bulk. For bulk, the selected small and large seeds were dyed with different colours of a commercial food dye for marking and then mixed with the remaining lot left after taking out the small and large seeds. Each subplot consisted of five 7-metre long rows with 40 cm between rows and was bordered with a single row of ungraded seeds of the same variety. Each plot was thinned to a stand of 20 plants per metre of row and the plants removed in thinning were used to determine the seedling characters.

The size of the seeds had no effect on germination percentage but showed a great influence on the early stage of plant growth (Table 1). In all cases, seedlings from the large seeds had greater vigour than those from small seeds. This was represented by the higher diameter and height of the seedlings, as well as by their greater fresh and dry weight. This increased vigour persisted in many cases throughout the crop growth. KAUFMANN—MACFADDEN (1963) in barley, WESTER (1964) in lima bean and SINGH *et al.* (1972) in soya bean obtained similar results.

The results in Table 2 show that the large seeds produced plants with greater final height, weight and base diameter and a greater number of pods and seeds per plant than plants produced from smaller seeds. Also, plants developed from larger seeds yielded more than those developed from smaller seeds. This was specially true in the case of early varieties and when they were planted in bulk. This finding confirms earlier observations of AUSTIN—LONGDEN (1964) who considered seed size to be a significant factor during the early stage of plant growth, and stated that if the growing season was long enough the early superiority might disappear entirely. Moreover, SUETSUGU—ANAGUCHI (1954) showed that there existed no difference in yield when the cotyledon weights of the early varieties were equalized by the removal of excess tissue prior to seeding.

Competition between progeny from large and small seeds is much more pronounced when they are planted in bulk. A more vigorous seedling grown from a large seed becomes a stronger competitor for light and soil factors. Many of the weak seedlings are suppressed and ultimately become barren. Consequently, in every case plants from smaller seeds showed a higher percentage of barrenness and lower yield when sown in bulk. This resulted in a decrease in the yield per plot (Table 2). SMITH—CAMPER (1975) obtained similar results in this crop.

The absence of any effect of seed size upon flowering and harvesting date, number of seeds per pod and size of the harvested seeds (100 seed weight), observed in the present study, confirms the report of BURRIS *et al.* (1973). BLACK (1957) in clover and AHMED—ZUBERI (1973) in rape seed, however, reported a relationship between the size of the seeds planted and the size of the seeds harvested.

The present study, therefore, suggested the grading of soya bean seeds prior to sowing and the use of uniformly larger seeds for cultivation, especially in the early varieties. A uniform seed size would also help in obtaining a more precise spacing in the row and should give a more uniform plant stand.

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Table 1

Effect of seed size on germination percentage and seedling performance

Variety	Seed size	Weight seed, mg	% germination	Characters of the seedlings											
				Diameter, cm			Height, cm			Fresh weight, g			Dry weight, g		
				Days after planting			Days after planting			Days after planting			Days after planting		
				15	20	25	15	20	25	15	20	25	15	20	25
SRF 425	Large	135a*	80.4a	7.8a	11.6a	20.2a	4.2a	9.5a	12.0a	1.2a	2.2a	3.8a	0.13a	0.26a	0.70a
	Small	81b	85.3a	6.0b	10.1b	18.1b	3.1b	8.0b	11.7a	0.8b	1.7b	3.1b	0.08b	0.19b	0.40b
	In bulk:														
	Large		83.2a	7.9a	11.9a	21.9a	4.4a	9.9a	12.3a	1.1a	2.5a	4.0a	0.12a	0.28a	0.71a
	Small		84.9a	5.8b	10.2b	16.8c	3.2b	8.1b	11.0b	0.7b	1.9b	2.5c	0.08b	0.17b	0.42b
EC11780	Large	81a	72.1a	7.1b	11.1a	20.9a	3.0a	6.2a	10.0a	1.1a	2.8a	3.9a	0.16a	0.32a	0.72a
	Small	50b	71.9a	6.5c	10.2b	16.3b	2.8ab	5.2b	8.1b	0.7b	1.4b	2.0b	0.07b	0.17b	0.32b
	In bulk:														
	Large		74.7a	8.0a	11.7a	22.3a	3.1a	6.7a	10.9a	1.2a	2.9a	4.1a	0.17a	0.35a	0.75a
	Small		73.4a	6.3c	10.0b	12.5c	2.5b	5.0b	7.3b	0.6b	1.4b	2.0b	0.08b	0.16b	0.30b
SJ2	Large	105a	90.1a	7.9a	10.3a	20.1a	6.9a	10.1a	14.1a	1.3a	2.0a	3.8a	0.13a	0.29a	0.58a
	Small	61b	89.8a	7.0ab	9.0b	16.3b	4.8b	8.0b	10.3b	0.7b	1.4b	2.2b	0.09b	0.19b	0.40b
	In bulk:														
	Large		89.2a	8.3a	10.5a	21.9a	7.0a	10.8a	15.0a	1.5a	2.2a	4.0a	0.14a	0.31a	0.61a
	Small		92.1a	6.8b	9.1b	13.0c	4.8b	8.1b	10.0b	0.7b	1.0c	1.5c	0.08b	0.16b	0.28c

* Means within a column for each variety and followed by the same letter do not differ significantly at 5% level

Table 2

Effect of seed size on yield and other characters

Variety	Seed size	Flower- ing date	Harvest- ing date	% of barren plants	Plant height, cm	Plant weight, g	Base diameter, cm	Fruit number (plant)	Seed number (fruit)	Seed number/ plant	100-seed weight, g	Yield/ plant, g	Yield/ plot, kg
SRF 425	Large	45.3a*	94.1a	6.5a	33.1a	20.3a	0.75a	43.1a	2.3a	97.5a	10.4a	11.0a	2.6a
	Small	47.0a	93.5a	7.1a	30.1b	17.8b	0.73a	38.2b	2.4a	90.2b	10.3a	9.2b	2.0b
	In bulk	46.8a	92.3a										1.8b
	Large			6.1a	35.5a	22.8a	0.80a	45.3a	2.2a	99.8a	10.2a	11.2a	
	Small			12.2b	27.1c	16.2b	0.65b	35.5c	2.4a	81.5c	10.0a	8.1c	
EC11780	Large	52.5a	98.3a	7.2a	50.5a	28.3a	0.61a	88.3a	2.8a	221.2a	6.3a	13.8a	3.2a
	Small	50.3a	97.8a	7.0a	48.9a	26.9b	0.60a	75.5b	2.7a	201.3b	6.2a	12.3b	2.7b
	In bulk:	51.5a	99.2a										2.4b
	Large			7.5a	53.4a	29.4a	0.63a	90.5a	2.6a	232.5a	6.4a	14.3a	
	Small			15.3b	43.1b	25.3b	0.58a	70.2c	2.7a	190.4b	6.5a	12.1b	
SJ2	Large	55.2a	112.2a	4.9a	62.9a	30.5a	0.89ab	61.3ab	2.3a	141.3ab	8.2a	11.5ab	2.6a
	Small	53.9a	113.5a	5.4a	62.8a	31.0a	0.91ab	60.1ab	2.4a	140.2ab	8.3a	11.4ab	2.5a
	In bulk:	55.8a	115.3a										2.1b
	Large			5.2a	63.5a	32.5a	0.94a	64.8a	2.4a	152.3a	8.6a	13.1a	
	Small			14.9b	61.3a	28.0b	0.85b	56.4b	2.3a	127.3b	8.4a	10.8b	

* Means within a column for each variety and followed by the same letter do not differ significantly at 5% level

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INTESTINAL SUCRASE ACTIVITY OF GROWING CHICKENS FED FINAL MOLASSES

It has been demonstrated that the use of final molasses in chicken feeding provokes a reduction in its performance and a considerable decrease in feeding efficiency (ROSENBERG 1953, ROSENBERG—PALAFOX 1956, PÉREZ 1970, CONNOR *et al.* 1972, SHARMA—PALIWAL 1973, ALVAREZ 1975). Considering that molasses has a large quantity of sucrase in its composition, it is possible to associate this with a deficiency in the intestinal sucrase activity, which per se limits the profit that could be made by birds with this type of feeding.

This work was carried out with the objective of studying the effect of final sugar cane molasses on the intestinal sucrase activity of chickens.

Animals and diets. Thirty male 791 hybrid chickens six weeks of age were distributed into three groups of 10 animals. They were fed diets with different levels of final molasses (0, 31.8 and 65.7% diet DM). Data of diet composition are presented in Table 1.

Preparation of the homogenates. The chickens were slaughtered by decapitation after a night fast (12 hr). The small intestine was removed and homogenized according to the method described by SIDDONS (1969).

Measurement of disaccharide activity. Disaccharide activity was determined according to the method of DAHLQUIST (1960). The protein content of the homogenates was analysed by the technique proposed by LOWRY *et al.* (1951), who employed bovine crystalline albumin as a protein pattern in order to calculate the specific activity (SA).

Design. A simple classification model was used for the analysis of variance. DUNCAN's multiple range test (1955) was used to compare the means.

The results obtained for the specific activity of intestinal sucrase are shown in Table 2. The SA of intestinal sucrase was significantly higher (1.35) for the diet with the highest level of final molasses than for the maize control (0.57). It is noteworthy, that depending on the quantity and source of carbohydrate supplied, the bird increases the SA of the enzymes related to its process of digestion and absorption (SIDDONS 1972).

When studying the status of intestinal sucrase in growing pigs fed molasses LY (1971) found that the SA was significantly higher in those fed maize meal than in those which were adapted to a diet based on high-test molasses. This author suggests that the results may be

Table 1
Composition of the diets (% of DM)

	Treatments		
	I Control	II 31.8% FM	III 65.7% FM
Final molasses	0.0	31.8	65.7
Maize	70.6	37.2	0.0
Fish meal	3.0	2.8	2.8
Torula yeast	9.7	9.3	8.7
Soybean meal	14.1	17.0	21.2
Calcium carbonate	1.4	0.4	0.0
Dicalcium phosphate	0.4	0.7	0.9
Sodium chloride	0.4	0.4	0.4
Premix ¹	0.3	0.3	0.3
Methionine	0.1	0.1	0.1
Analysis			
DM, %	84.7	82.1	78.0
N × 6.25, %	20.1	20.1	20.4
ME, Mcal/kg	3.5	3.0	2.5

¹ 1 kg contains: 250 g NaCl, 225 g MgSO₄, 150 g MnSO₄ · H₂O, 6 g FeSO₄ · 5 H₂O, 4 g ZnCO₃, 350 000 IU vitamin A and 250 000 IU vitamin D

Table 2
Specific activity of the intestinal sucrase of birds fed maize or final molasses

	% final molasses in the diets			
	0	31.8	65.7	SE
Specific activity ¹	0.57 ^a	0.86 ^b	1.35 ^c	±0.07

^{a,b,c} Means without letter in common differ at $P < 0.001$

¹ Expressed as quantity that hydrolyses 1 μ mol of disaccharide in 1 min at 37 °C/mg of protein

confounded by other physiological factors derived from the nature of the diet, such as the rate of passage and the osmolarity of the intestinal digesta.

The poor nutritional performance observed in chickens fed molasses (ALVAREZ 1975) could be accounted for by a decrease in the metabolizable energy concentration when the levels of final molasses in the diet were increased. It was also found that these effects were related to a greater rate of passage of the ingesta and the appearance of carbohydrates in the animal excreta (ALVAREZ 1975).

This work indicates that the sucrase activity is not responsible for the loss of carbohydrates in the faeces. If this were so, it could be thought that the absorption of monosaccharides in the intestine might be affected.

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GENETIC IMPROVEMENT OF COWPEA [*VIGNA UNGUICULATA* (L.) WALP.] GREEN POD YIELD

A meaningful selection programme should be built upon the intricate inheritance pattern of yield and the other components contributing to yield, as well as the inter-relationship existing between the different characters. Though some work to this effect has been reported in cowpea by TIKKA *et al.* (1977), ARYEETEEY—LAING (1973), BRITTINGHAM (1950) and SENE (1968), these reports deal with cowpea as a pulse or fodder crop and not as a vegetable.

Cowpea is a popular vegetable in India, used either as green tender pods or as shelled beans from mature pods. The present investigation relates to the types suitable for using as green tender pods.

Nineteen cowpea varieties which are a random sample of the germplasm maintained at the Institute, collected from different cultivated areas in India, were grown in a randomised block design with four replications. Days to flower (X_1), days to 50% flowering (X_2), height of the plants in cm (X_3), spread of the plant in cm (X_4), length of peduncle in cm (X_5), number of peduncles (X_6), number of primary branches (X_7), mean length of pods (X_8), mean number of pods set per peduncle (X_9), percentage of borer infected pods (X_{10}), mean weight of pod (X_{11}) and pod yield per plant (Y) were recorded. The heritability and other correlations of different characters were estimated using the following method as outlined by BURTON (1952) and HANSON *et al.* (1956). The varieties mean square of the standard analysis of variance procedure has an expected value of $g^2 + e^2$ and the error mean square an expected value of e^2 where g^2 is the total genetic variance, e^2 the environmental variance and e^2 the number

of replications. By equating the actual mean square to the expected values the values of g^2 and e^2 were derived and heritability in a broad sense was estimated as $g^2/e^2 g^2 + e^2$. A similar procedure applied to the analysis of covariance between two characters gives an estimate of genotypic covariance and environmental covariance. The genotypic covariance divided by the root of the corresponding genotypic variances gives the genotypic correlations, and so on.

The path coefficient analysis was done using the method given by DEWEY—LU (1959). Selection indices were worked out using methods given by RAO (1952). The computational work was done using the DCM Microsystem 1122.

The range of variation of the different characters studied among the varieties are given in Table 1. It can be seen that a wide range of variation exists for the different characters considered. The heritability, phenotypic, genotypic and environmental correlations are given in Table 2. All the characters recorded had medium to high heritability, indicating that the material collected has sufficient variability and a selection programme is likely to be effective. These results are in conformity with those obtained by TIKKA *et al.* (1977). While seed yield was the selection parameter under consideration by these authors, the pod yield was considered in the present paper. Spread of the plant, length of peduncle, number of peduncles, length of pod, percentage of borer infestation and weight of pod had significant genetic correlation with yield. Spread of the plant, length of peduncle, numbers of peduncles are all genetically interrelated and contribute to an increase in yield through length of pod, which is another character having high correlation with yield. The percentage borer infestation increases yield through an increase in the pod set, but otherwise this character has no correlation with any other character. An almost identical result has been obtained by TIKKA *et al.* (1977). But a similar pattern to that outlined above, where the paths of influence of the different characters are clear, is not seen in their study.

To test whether a selection index approach would improve the efficiency of selection for increasing yield, selection indices were worked out using all the characters, deleting one character at a time, two characters at a time or three characters at a time. The relative efficiency including all characters and two other combinations which gave higher efficiency than this are given in Table 3.

The efficiencies did not increase when three characters were deleted at one time. The index excluding days to 50% flowering (X_2) and pod set per peduncle (X_8) which gave the maximum efficiency is given below:

$$I = 6.06 X_1 + 0.14 X_3 + 1.13 X_4 - 0.35 X_5 - 0.89 X_6 - 8.98 X_7 + 19.71 X_9 - 0.92 X_{10} - 0.07 X_{11} + 1.52$$

Table 1
Range of variation for different characters studied

Character		Range	
		max.	min.
Days to flower	X_1	51	35
Days to 50% flowering	X_2	82	41
Height of the plants in cm	X_3	109.4	16.8
Spread of the plants in cm	X_4	57.47	24.5
Length of peduncle in cm	X_5	38.17	10.29
No. of peduncles	X_6	35.20	9.40
No. of primary branches	X_7	5.00	2.25
Length of pods	X_8	10.1	5.3
Mean No. of pods set per peduncle	X_9	4.16	1.23
Percentage of borer infested pods	X_{10}	40.00	9.09
Mean weight of pod	X_{11}	8.9	2.5
Pod yield per plant	Y	137.80	13.30

While the best index for improvement of seed yield/plant suggested by TIKKA *et al.* (1977) gave 22.7% over straight selection the above index gives 46% over straight selection for improvement of the total pod yield.

The results outlined suggest that due to the heritability of yield being more than medium, the yield itself could be used as a selection criterion. But for some reason, if there is a limit as to the stringency of selection that can be exercised, the index derived above could give quicker results for a higher percentage of varieties selected.

Apart from the genetic relations worked out above with their implications in plant breeding, it would be useful if a better knowledge of the characters which cause higher pod yield could be obtained. This cannot be done by a simple correlation study but only through path coefficient analysis. The causal pathways of different characters on determination of yield is given in Table 4. Pod set/peduncle, which did not show any significant correlation with yield, has shown the maximum positive direct effect. But an equally large indirect effect, mainly through the number of peduncles, nullifies this effect. A similar result is true of the number of peduncles. It has the highest negative direct effect and highest positive indirect effect mainly through the pod set per peduncle. This relation between the two characters thus imposes a strong constraint in realising very high yields. It is surprising that this sort of relation is exhibited by almost all the characters examined except for the height of the plant, which does not bear a strong relation with yield. These contradictory relations exhibited by the characters go to show that there are a lot of yield barriers which prevent the increase of yield.

The unexploited genetic variation which was apparent in Table 1 could be due to intricate counterbalancing relations which prevent the expression of a very high yield. Apart from selection as a methodology of improvement, it thus becomes necessary to find out ways and means of breaking these relations, like trying to identify varieties where these relations do not exist, and mutation breeding.

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Table 2
Phenotypic, genotypic and environmental inter-correlations

	X ₁ Days to first flower	X ₂ Days to 50% flowering	X ₃ Height of plant	X ₄ Spread of plant	X ₅ Length of peduncle (cm)	X ₆ No. of peduncles
h²	64.23	74.08	91.37	88.18	74.41	64.89
X ₁	1.0000 1.0000 1.0000	0.8947** 1.0001** 0.5033	0.3589** 0.4286 -0.2025	0.6226** 0.7180** -0.0328	0.1387 0.2093 -0.1567	0.3559** 0.5326* -0.1972
X ₂		1.0000 1.0000 1.0000	0.3338** 0.4056 0.0005	0.5812** 0.7543** -0.0568	0.1099 0.2109 -0.1812	0.4058** 0.6011** -0.0363
X ₃			1.0000 1.0000 1.0000	0.6873** 0.7387** 0.2464	0.3952** 0.4431 0.2016	0.4599** 0.5238** 0.3249
X ₄				1.0000 1.0000 1.0000	0.6364** 0.6869** 0.4602	0.6984** 0.7807** 0.5291*
X ₅					1.0000 1.0000 1.0000	0.5250** 0.6343* 0.2809
X ₆						1.0000 1.0000 1.0000
X ₇						
X ₈						
X ₉						
X ₁₀						
X ₁₁						

Note: ** Significant at 1%. * Significant at 5%

and heritability of different characters in cowpea

X_7 No. of primary branches	X_8 Length of pod	X_9 Pod set per peduncle	X_{10} % borer infestation	X_{11} Weight of pod	Y Total weight of pods
64.28	82.10	52.84	72.35	90.80	60.78
0.4875**	0.2294	0.1436	-0.2529	0.4144**	0.2954**
0.6970**	0.2550	0.2184	-0.3023	0.4769	0.4592
-0.1452	0.0939	-0.0160	-0.0700	-0.0728	-0.1619
0.5350**	0.1908	0.1590	-0.2494	0.4073	0.3291**
0.7813**	0.2031	0.1650	-0.3458	0.5198*	0.4964
-0.1346	0.1505	0.1596	0.0140	-0.0374	-0.0125
0.2626	0.2683	0.1649	-0.1789	0.1029	0.3987**
0.3442	0.2859	0.2307	-0.2753	0.1177	0.5106
-0.0068	0.1668	0.0021	0.2912	-0.0146	0.0991
0.5282**	0.4890**	0.1117	-0.0074	0.4011*	0.5801**
0.6394**	0.5706**	0.0618	-0.0742	0.4275	0.7721**
0.2278	0.0245	0.2942	0.2869	0.0540	0.0690
0.2703	0.7033**	-0.1717	0.2811*	0.3479**	0.5199**
0.3013	0.9292**	-0.3706	0.3370	0.4154	0.8131**
0.2049	-0.1073	-0.1745	0.1272	0.0126	-0.0850
0.6591*	0.3483**	0.5828**	0.0143	0.2108	0.4604**
0.8037**	0.4782	-0.0915	-0.0362	0.2290	0.5978**
0.3955	-0.0034	0.2750	0.1256	0.0591	0.2371
1.0000	0.1906	0.1104	-0.1800	0.2392	0.3331
1.0000	0.3133	-0.0995	-0.4198	0.2877	0.4067
1.0000	-0.1463	0.4102	0.3382	0.0325	0.2110
	1.0000	-0.3807**	0.4109*	0.5856**	0.5679**
	1.0000	-0.5817**	0.5062	0.6540**	0.7582
	1.0000	0.0085	0.0936	0.0496	0.0400
		1.0000	-0.3037*	-0.3245**	-0.2049
		1.0000	-0.6624**	-0.4912	-0.3867
		1.0000	0.2934	0.0228	0.0336
			1.0000	0.3778*	0.2738*
			1.0000	0.4491	0.4053*
			1.0000	0.0261	0.0152
				1.0000	0.5454**
				1.0000	0.6993**
				1.0000	0.0413

Table 3
Efficiencies of selection indices using different characters

Characters	GA Constant	RE (%) over straight selection
X_1 to X_{11} and Y	21.65	119
X_1, X_3 to X_{11} and Y	25.51	140
X_1, X_3 to X_8, X_{10}, X_{11} and Y	26.66	146

Table 4

Direct and indirect paths in determination of total pod yield in cowpea

	Indirect effects through										
	X ₁	X ₂	X ₃	X ₄	X ₅	X ₆	X ₇	X ₈	X ₉	X ₁₀	X ₁₁
X ₁	—	0.7757	0.0492	1.1684	0.1344	—2.1850	1.3680	0.4268	0.6160	—0.1397	0.2999
X ₂	—1.9848	—	0.0458	1.0907	0.1065	—2.7914	1.5013	0.3550	0.6820	—0.1379	0.2948
X ₃	—0.7961	0.2894	—	1.2898	0.3830	—2.8235	0.7369	0.4992	0.7073	—0.0909	0.0745
X ₄	—1.3811	0.5039	0.0943	—	0.6167	—4.2878	1.4822	0.9099	0.4791	—0.0041	0.2904
X ₅	—0.3077	0.0952	0.0542	1.1943	—	—3.2232	0.7585	1.3086	—0.7365	0.1554	0.2518
X ₆	—0.7895	0.3518	0.0631	1.3107	0.5088	—	1.8496	0.6481	2.4999	0.0079	0.1526
X ₇	—1.0815	0.4638	0.0360	0.9912	0.2619	—4.0465	—	0.3546	0.4735	—0.0995	0.1732
X ₈	—0.5089	0.1654	0.0368	0.9177	0.6815	—2.1384	0.5349	—	—1.6330	0.2272	0.4239
X ₉	—0.3186	0.1378	0.0226	0.2096	—0.1664	—3.5781	0.3098	—0.7084	—	—0.1680	—0.2349
X ₁₀	0.5606	—0.2162	—0.0245	—0.0139	0.2724	—0.0878	—0.5051	0.7645	—1.3027	—	0.2735
X ₁₁	—0.9193	0.3531	0.0141	0.7527	0.3371	—1.2942	0.6712	1.0896	—1.3919	0.2089	—
Total direct effects	—2.2184	0.8670	0.1372	1.8767	0.9691	—6.1395	2.3062	1.3607	4.2895	0.5531	0.7239
Total indirect effects	2.5138	—0.5379	0.2615	—1.2966	—0.4492	6.5999	—2.4731	—1.2928	—4.4944	—0.2793	—0.1785

Residual effect: 0.05

EFFECT OF PELLETING ON WATER UPTAKE AND THE GERMINATION OF SUGAR BEET SEED

At the present time low field emergence and poor stands are considered to be the most important problems in sugar beet growing. For the most part these are caused by unfavourable soil conditions, in addition to plant pathogens and pests (STEHLIK—NEUWITH 1928). The role of one of the factors dealt with, the sensitivity of sugar beet seed to excessive moisture in the substratum, has been well known for a long time (GOFF 1897). This is caused mainly due to the restriction of the oxygen supply to the embryo on the grounds of the impermeability of the fruit, the mucilage layer around the cap and the competition for oxygen by bacteria growing on the clusters (CHERTRAM—HEYDECKER 1967, HEYDECKER—CHERTRAM 1971, HEYDECKER *et al.* 1971). Seed samples differ with respect to sensitivity to an excess of water in the substratum (RENARD 1979). The only route for the water and oxygen uptake by seeds in undamaged clusters is the basal pore — so long as the imbibed seed lifts the cap. The basal pore is a hole about 0.5 mm in diameter on the opposite side of the fruit to the cap. It is filled by remnants of vascular tissues. When the pore is stuffed with water, the oxygen supply cannot be sufficient to sustain germination. The detrimental effect of excessive water on germination may be removed by a pure oxygen atmosphere in jars where germination takes place (GOFF 1897) or by hydrogen peroxide (FISCHNICH *et al.* 1959). Hydrogen peroxide also improves the germination of monogerm sugar beet seed under test conditions (TEKRONY—HARDIN 1969). According to field experience it is usually supposed that pelleted seeds need higher soil moisture than natural ones. The lower germination of ÚNS and VÚRV pellets compared to natural seed at low moisture was found in laboratory tests, but the optimum moisture was the same. By contrast, Vitana pellets germinated better at low moisture than natural seed. Removing part of the cortex with sulphuric acid increased the rate of germination of natural seed at low moistures. However, the adverse effect of excessive water

Table 1

The effect of moisture on germination (as a %) of pelleted sugar beet seed at 9 °C

Days	ml/dish	VÚRV		ÚNS		VITANA		Natural seed	
		H ₂ O	H ₂ O ₂	H ₂ O	H ₂ O ₂	H ₂ O	H ₂ O ₂	H ₂ O	H ₂ O ₂
8	3	24.3	0.0	4.3	3.3	0.3	0.0	29.3	1.0
	5	25.3	24.3	18.3	26.6	2.0	2.6	53.6	30.6
	7	6.6	14.3	4.3	42.3	1.3	28.6	47.6	44.6
	9	3.3	13.6	3.0	29.6	0.6	6.3	33.6	11.6
10	3	48.6	5.6	8.6	17.9	8.6	1.0	59.3	4.6
	5	39.9	60.6	35.3	54.3	19.6	49.2	66.9	67.6
	7	9.6	16.6	12.9	61.3	7.3	64.9	54.2	72.2
	9	4.9	26.6	15.3	53.3	4.6	51.3	41.9	65.9
13	3	56.6	31.2	25.2	34.5	40.6	10.6	64.6	27.6
	5	47.9	70.9	50.9	64.8	45.6	65.8	71.9	76.6
	7	15.2	29.2	33.2	70.6	15.6	65.8	56.5	76.8
	9	11.5	37.9	23.3	67.5	8.6	67.6	44.9	78.5
16	3	56.9	36.2	25.2	36.1	46.2	14.2	68.6	47.9
	5	55.2	76.2	61.9	68.1	60.9	70.4	75.5	78.6
	7	29.8	42.2	53.5	75.9	32.2	79.8	60.8	78.8
	9	20.8	45.5	30.3	69.1	14.9	70.6	48.9	80.1

Table 2

The effect of moisture on germination (as a %) of pelleted sugar beet seed at 13 °C

Days	ml/dish	VÚRV		ÚNS		VITANA		Natural seed	
		H ₂ O	H ₂ O ₂	H ₂ O	H ₂ O ₂	H ₂ O	H ₂ O ₂	H ₂ O	H ₂ O ₂
3	3	1.6	0.0	0.0	0.0	0.2	0.0	0.8	0.0
	5	3.6	1.2	0.0	0.0	0.4	2.0	19.2	8.2
	7	0.4	2.8	0.0	1.2	0.8	2.6	24.4	7.6
	9	0.0	6.8	1.0	1.0	0.5	3.6	18.0	7.6
6	3	50.8	35.2	24.0	5.2	58.0	20.4	70.8	6.4
	5	23.2	66.2	34.0	72.0	13.6	77.6	70.0	80.6
	7	3.6	34.8	8.4	71.6	4.4	78.2	38.4	77.2
	9	2.0	31.2	9.2	70.6	9.2	79.2	41.2	82.6
9	3	71.2	54.4	48.8	26.8	76.6	56.4	83.6	32.4
	5	32.0	81.6	48.8	82.0	34.8	83.2	72.0	85.0
	7	6.0	51.6	16.8	78.2	10.8	83.0	39.6	80.4
	9	6.0	52.8	23.2	79.6	18.0	88.0	44.4	85.6
14	3	79.2	66.0	68.0	49.2	84.0	72.8	86.8	78.0
	5	44.6	82.0	63.6	86.2	52.0	86.6	78.4	88.0
	7	14.4	56.8	25.2	82.2	24.8	85.6	48.4	83.6
	9	12.0	56.4	27.2	83.0	29.6	88.0	53.2	88.0

on the germination of pelleted seed was much more remarkable (VEVERKA *et al.* 1979). The increased sensitivity of some pelleted sugar beet seed to excessive moisture is also reported by HIBBERT *et al.* (1975).

The development of three pelleting materials in Czechoslovakia made it possible to study the germination and water uptake of the same seed stock of monogerm sugar beet seed pelleted in different materials.

Natural, non-rubbed seed of cv. Monohybrid, graded to 3.5–4.5 mm, were put to germinate in 12 cm diameter Petri dishes on two layers of Filtrak 389 filter paper discs to which 3, 5, 7, or 9 ml of distilled water or 3% hydrogen peroxide were added. In six repetitions, fifty pellets were put to germinate in each dish and kept in the dark in the thermostat at 9°C, 13°C or 21°C. Seeds were counted as germinated and removed when the radicles were at least 2 mm in length. Pellets of the same seed stock were made from the following materials: Vitana: limestone + silicate dust + gypsum, Uns: wood dust + fly ash from separators + starch, Vurv: compost. All three pellets were made by the rolling process and graded to 4–5.25 mm. Seed used for pelleting was identical with the stock used for testing natural seed.

The highest rate of germination of natural monogerm seed was found to be at 21°C when 5 ml water was added to each dish. Germination decreased at higher moisture and was negligible at 3 ml (Table 3). Within 4–8 days the difference between 3 and 5 ml disappeared. Germination at 3 and 5 ml was about 80%, while at 7 and 9 ml it was less than 50%.

All three kinds of pelleted seeds (of the same seed stock) germinated more slowly than natural seed, the highest rate being at 3 ml and decreasing with increasing moisture. After 2 and 4 days the rate of germination of pelleted seeds was lower than that of natural seed at the same moisture. However, the differences in the rate of germination at 3 ml moisture level disappeared after 8 or 11 days and the germination of pelleted and natural seeds was the same. At higher moistures the germination of pelleted seeds was much lower than that of natural seed at corresponding moisture. The seed in Vitana pellets was the most sensitive to an excess of water.

Table 3

The effect of moisture on germination (as a %) of pelleted sugar beet seed at 21 °C

Days	ml/dish	VÚRV		ÚNS		VITANA		Natural seed		Natural seed		ÚNS	
		H ₂ O	H ₂ O ₂	H ₂ O	H ₂ O ₂	H ₂ O	H ₂ O ₂	H ₂ O	H ₂ O ₂	pretreated in		pretreated in	
										H ₂ O	H ₂ O ₂	H ₂ O	H ₂ O ₂
2	3	0.6	0.6	0.0	0.0	0.3	0.0	4.0	0.0	43.6	24.0	8.6	10.3
	5	1.6	13.6	1.3	7.0	2.0	11.6	47.3	23.3	66.3	63.6	36.9	49.6
	7	0.0	8.3	0.6	16.6	0.0		33.3	49.3	52.0	58.6	6.0	25.6
	9	0.3	7.3	0.0	17.3	0.0		25.6	47.6	50.0	49.6	6.3	18.6
4	3	36.3	15.6	11.6	1.3	33.3	16.3	45.0	6.6	77.6	68.0	54.6	45.6
	5	18.3	74.6	21.0	80.0	4.3	46.3	71.6	75.6	75.3	76.3	68.6	78.6
	7	1.0	36.6	1.3	81.0	— 0.0		40.6	86.3	56.3	66.0	14.0	40.3
	9	1.6	28.3	0.6	80.0	0.0		34.3	86.6	58.3	61.3	12.6	40.6
8	3	78.0	65.6	60.3	32.0	67.6	74.3	73.6	58.0	90.6	85.6	86.0	80.6
	5	31.3	83.0	49.3	87.6	14.0	84.0	77.3	83.3	78.3	79.0	75.0	82.6
	7	3.6	48.6	6.0	83.0	0.6		45.0	87.6	60.6	69.0	29.0	67.0
	9	7.6	35.6	3.6	85.6	1.6		38.3	89.0	63.6	63.0	22.0	52.0
11	3	80.3	74.6	78.3	51.6	75.3	82.6	78.0	73.6	90.6	85.6	87.0	85.6
	5	39.0	86.0	52.3	89.3	21.0	84.6	78.3	84.0	79.3	79.0	77.0	82.6
	7	7.6	53.0	14.3	84.0	3.6		49.3	87.6	62.6	70.3	36.3	69.0
	9	10.6	39.3	11.0	86.0	5.0		43.6	90.0	63.6	63.3	24.3	53.0

At 9°C (Table 1) 5 ml water per dish was the optimum moisture level for both natural and pelleted seeds. Vurv seed was the best of the pelleted ones at the lowest moisture. On the other hand, Vitana seed was the most sensitive to an excess of water, as at 21°C. The differences in the rate of germination and the germination at different moisture levels were smaller than those at 21°C. The facts are in accordance with the possible role of the following factors. At lower temperature: 1. The amount of oxygen dissolved in water is higher (at 9°C: $11.19 \text{ mg O}_2 \cdot \text{l}^{-1}$, at 21°C: $8.63 \text{ mg O}_2 \cdot \text{l}^{-1}$); 2. the germination processes are slower and the need of oxygen per time is lower; 3. the longer the germination period the more oxygen can reach the seed. It may be that for those reasons the effect of excessive moisture is less detrimental. The results obtained at 13°C (Table 2) are intermediate between those found at 9°C and 21°C. Therefore, they confirm the trends mentioned above.

Some effects of pelleting on germination at different moistures may be explained by the following results: In a trial conducted in the same manner as before, the pellets were removed from the Petri dishes after 24 hours, the pelleting material was separated from the seed and the amount of water in the material and in the seeds was checked by weight. This was only possible at 3 and 5 ml, not at higher moisture, as it was impossible to pick the material up without traces of the filter paper.

The Uns pelleting material is able to take up much more water than the others (Table 4). The lowest amount of water can be taken up by the Vitana material — less than half of the amount taken up by Uns. The highest amount of water taken up by seeds at 3 ml moisture was found for Vurv pellets and the lowest for Uns. This is in a good agreement with the results of germination at this moisture. The rate of germination was the highest for Vurv and the lowest for Uns pellets. On the other hand no difference of practical value between the amounts of water taken up by seeds in different pellets was found at 5 ml. There were important differences between natural and pelleted seeds. Natural seed took up 0.81 g water per 100 clusters at optimum moisture of 5 ml. The highest amount of water taken up by seed pelleted in Vitana material was only 0.51 g per 100 clusters. From this comparison it is apparent that the pelleted seeds were insufficiently provided with water. In spite of this the optimum moisture for pelleted seeds was only 3 ml at 21°C. These results show that pelleted seeds need a higher amount of water, but if provided this limits the oxygen flux to the seed. This negative correlation between uptake of water and oxygen takes place also in natural or rubbed seeds, but is less noticeable. Differences in water uptake between samples of seed pelleted in different materials are much smaller than those between pelleted and natural seed. This also corresponds with differences in germination rate.

Table 4
*The effect of moisture on water uptake of pelleted sugar beet seed
after 24 hours imbibition*

Seed	ml/dish	Dry weight	Amount of water in			
			pelleting material		clusters	
			\bar{x}	i.c.	\bar{x}	i.c.
ÚNS	3	2.03	1.04	0.023	0.33	0.007
	5	1.99	1.71	0.040	0.46	0.018
VÚRV	3	2.71	0.81	0.061	0.42	0.034
	5	2.70	1.38	0.034	0.46	0.005
VITANA	3	4.21	0.56	0.011	0.35	0.006
	5	4.16	0.68	0.035	0.51	0.026
Natural seed	3	1.13	—	—	0.45	0.007
	5	1.11	—	—	0.81	0.029

i.c. = interval of confidence at $P = 0.05$

To confirm that the germination of pelleted seeds is limited by shortage of oxygen at higher moisture, all the tests were simultaneously conducted in water and 3% hydrogen peroxide. This concentration proved to be phytotoxic at low moisture and delayed germination. The rate of germination and the germination of natural seed were substantially increased at 7 and 9 ml moisture, sometimes at a higher level than was reached at the optimum dose of water. This confirms that also in natural seed there is a competitive relationship between uptake of water and possible oxygen supply.

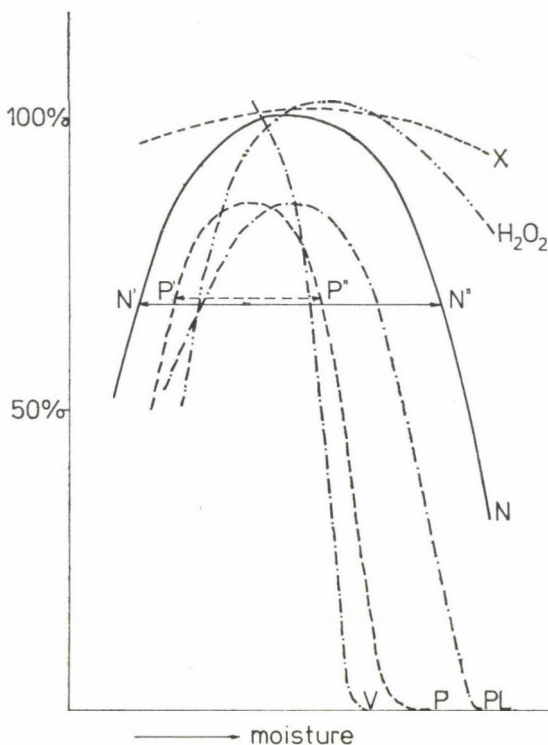


Fig. 1. Schematic relationships between the moisture content of the substratum and the rate of germination of pelleted seed. (The highest rate of germination of natural seed = 100%.) (N — natural seed; V — pelleted seed germinating well at low moisture; P — pelleted seed [majority of pellets usually used]; P_L — pelleted seed germinating at low temperature; X — the ideal germination curve; H₂O₂ — germination in 3% hydrogen peroxide]

Stimulation of germination was highest for pelleted seed germinating at high moisture. The rate of germination of Uns and Vitana pellets was usually higher than that in natural seed germinated in water. In the case of Vurv pellets the effect of hydrogen peroxide was slighter, possibly due to the inactivation by organic material.

This experiment does not prove the direct effect of hydrogen peroxide in supplying the seeds with free oxygen and does not exclude the stimulation of germination in some other way as well (oxidation of germination inhibitors, etc.). To find the persistence of the hydrogen peroxide under test conditions identical amounts of 3% hydrogen peroxide were poured into empty Petri dishes. As found by the manganometric method, the concentration decrease was negligible after five days. With respect to persistence, hydrogen peroxide is assumed to be active throughout the period of the tests.

For other possible explanations of the role of oxygen and hydrogen peroxide, natural seed and Uns pellets were put in 5 ml of water or 3% hydrogen peroxide in Petri dishes, removed after 24 hours, dried at room temperature and put to germinate after a week simultaneously with other variants (Table 3). Pre-treatment of natural seed increased the rate of germination very noticeably, mainly at high moisture. Surprisingly, there were no great differences between pre-treatment with water and hydrogen peroxide. The increase in germination at high moisture due to hydrogen peroxide pre-treatment was not so high as in the variant germinated in hydrogen peroxide. This indirectly confirms the fact that hydrogen peroxide positively affects the germination within the duration of the test and not only by the oxidation of inhibitors at the beginning of the trial. Furthermore, the pre-treatment improved the germination of pelleted Uns seed. The effect of hydrogen peroxide was greater than that of water. It is supposed that hydrogen peroxide may positively affect the germination via the pelleting material.

An attempt was made to make some generalizations and conclusions from the very complex data of the trials. The relationships between the rate of germination and the amount of water in the substratum and seed used in the trials mentioned above and in earlier papers (VEVERKA *et al.* 1979) are illustrated in Fig. 1. Considering the highest rate of germination of natural seed as 100%, it can be seen that the rate of germination decreased at lower and higher moisture (curve N). For most of the pelleted seeds (P) the highest rate of germination was lower than that of natural seed and was reached at lower moisture. Optimum moisture for natural seed slightly inhibits the germination of pelleted seeds. However, at low moisture the rate of germination decreased as much or even more than it did for natural seed. At low temperature the effect of excessive moisture is less detrimental — seed germinates a little better (curve P_L). One of the pelleted seeds germinated better than natural seed at low moisture (V) (see VEVERKA *et al.* 1979). By contrast, at high moistures the rate of germination of all pelleted seeds tested decreased sharply. The same rate of germination (or higher) can be reached by natural seed in a wider range of different moistures (N'—N'') than by pelleted seed (P'—P''). As shown, pelleting narrows the extent of ecological conditions suitable for sugar beet germination. Despite extensive efforts by many authors the maximum gain in seed stimulation is a few per cent under suitable conditions. As indicated in Fig. 1, the possibilities of improvement at high moisture, and partly at low moisture, are considerable. The ideal curve for the rate of germination related to moisture is marked X. The main aim of seed pre-treatment before pelleting ought to be an improvement in germination under a broader range of conditions, not only in tests conducted under optimum conditions. The curve of germination shows some possibilities with the aid of hydrogen peroxide.

The germination of sugar beet seed is affected by many factors. The results show that even a slight water surplus has a much greater negative effect than was found for germination inhibitors (DE KOCK—HUNTER 1950, SNYDER *et al.* 1965, BATTLE—WHITTINGTON 1969, INOUE—YAMAMOTO 1974). Pelleting itself cannot be regarded as only a mechanical supplement of a material to the seed. During the processing the seed is wetted or washed. The seed is kept under wet conditions at least for some time. Washing can improve the germination (LONGDEN 1971, 1973, 1976, SCOTT *et al.* 1972). Germination inhibitors may be removed and other favourable processes may take place. The difference between the rate of germination of pre-treated and natural seed is much higher under high substratum moisture, as shown above. Besides the possible reasons of this effect mentioned in the literature, comparison with the effect of hydrogen peroxide shows one other mechanism that could be of importance. After wetting, some biochemical processes may start in the seed. During imbibition, drying and imbibition at the beginning of germination the seed is able to take up oxygen. Some oxidative processes may take place and shortage of oxygen in the seed in thus overcome. Under changing temperature and moisture conditions in the soil the wetting and drying may take place some time before the seed germinates. This is why the effect of different pre-treatments often fails in the field. For the same reason the effect of pelleting is not so adverse under the changing conditions in the soil as in tests under constant conditions. All three pelleted seeds tested emerged well in the field, but this does not mean that the germinating properties of pelleted seeds should not be improved as suggested above. In wet soil these seeds may fail.

The conclusions for the testing of germination proved to be very important. Many failures met with during research on Vurv and Vitana pelleting materials and processing were later explained as being due to poor testing conditions and not to unsuitable materials or processing. For testing unknown pellets the optimum moisture of the substratum has to be checked first. Some pelleted seeds germinate badly in tests, but emerge well in the field. They need changing conditions to be able to take up oxygen and germinate.

Only the relationship between water and oxygen uptake and some other processes taking place in germinating pelleted seeds were studied. The ability of natural and pelleted seeds to take up water from the soil was not compared and the results are not related to this aspect.

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STUDIES ON THE UTILISATION OF PHOSPHORUS BY PEA AT DIFFERENT STAGES OF GROWTH USING LABELLED SUPERPHOSPHATE

Pea (*Pisum sativum* L.) is a common leguminous pulse crop of India. It has been reported that legumes respond favourably to phosphatic fertilisation (SINHA—SINGH 1967, SHARMA—MISRA 1961). It was, therefore, intended to study the response of pea crop to phosphatic fertilisation under different modes of application using labelled superphosphate at different stages of growth in order to find out its efficient utilisation for maximal beneficial effects. The data on the growth and yield of this investigation were reported earlier (SINHA—SINGH 1967).

The pea variety *Bonne ville* was grown in 7.31×4.57 m plots at the Agronomy Division of this Institute to accommodate ten rows at a spacing of 45 cm. The soil was light sandy loam having a pH of 7.6, and containing 196, 13 and 206 kg per ha available N (determined according to SUBBIAH—ASIIJA 1956), P_2O_5 (determined according to OLSEN *et al.* 1954 by extraction with $NaHCO_3$) and K_2O (determined according to TOTH—PRINCE 1949) respectively. Labelled single superphosphate in two doses (30 kg and 60 kg P_2O_5 /ha), with a basal dose of 10 kg N/ha as ammonium sulphate, was applied with three methods of placement (broadcast, in contact with the seed and 3–5 cm below the seed) in a randomised block design having four replicates. One plot was treated with 10 kg N/ha only and the other was an unfertilised control plot.

Table 1

*Effect of different treatments on the concentration
of P in the pea plant at different stages of growth
(mg/g plant materials average of 4 replicates)*

Treatments ^a P_2O_5 /ha	7 weeks	9 weeks	11 weeks	13 weeks
Control	2.80	2.54	2.37	2.26
Nitrogen (10 kg N/ha as broadcast) only	2.79	2.43	2.42	2.30
30 kg broadcast	2.98	2.69	3.07	2.52
60 kg broadcast	2.90	3.07	3.72	2.82
30 kg 3–5 cm below seed	3.52	4.06	3.97	2.82
60 kg 3–5 cm below seed	4.06	4.50	4.68	3.15
30 kg just below the seed	3.57	3.55	3.40	2.64
60 kg just below the seed	3.84	4.03	4.03	3.04

Stage

SEm = 0.088

CD(5%) = 0.248**

Methods

SEm = 0.078

CD(5%) = 0.219**

Levels of P

SEm = 0.063

CD(5%) = 0.178**

Stage × Methods

SEm = 0.156

CD(5%) = 0.439*

Methods × Levels of P, Stage × Levels of P and Stage × Methods × Levels of P interactions were not significant.

* Significant at 5%

** Significant at 1%

^a All the phosphorus treatments received 10 kg N per hectare as a basal dose

Table 2

Effect of applied phosphorus on the fraction of total P in the pea plant derived from the fertiliser at different stages of growth
(expressed as percentage; average of 4 replicates)

Treatments ^a P ₂ O ₅ /ha	7 weeks	9 weeks	11 weeks	13 weeks
30 kg broadcast	0.47	1.13	1.08	5.85
60 kg broadcast	0.57	2.88	3.93	6.81
30 kg 3—5 cm below seed	20.47	49.11	49.15	54.97
60 kg 3—5 cm below seed	29.28	61.91	62.65	65.26
30 kg just below the seed	22.66	46.14	52.78	53.40
60 kg just below the seed	31.94	49.58	53.56	55.71

Stage

SEm = 2.189

CD(5%) = 6.172**

Methods

SEm = 1.866

CD(5%) = 5.261**

Levels of P

SEm = 1.177

CD(5%) = 3.319*

Stage × Methods

SEm = 3.78

CD(5%) = 10.657**

Methods × Levels of P, Stage × Levels of P and Stage × Methods × Levels of P interactions were not significant.

* Significant at 5%

** Significant at 1%

^a All the phosphorus treatments received 10 kg N per hectare as a basal dose

Samples were collected at 7, 9, 11 and 13 weeks after sowing and analysed for total P colorimetrically by the vanadomolybdate method (KOENIG—JOHNSON 1942) and for radioactive P by the method of MACKENZIE—DEAN (1950). The data were statistically analysed according to SNEDECOR—COCHRAN (1965).

Concentration of P in the pea plant. The phosphorus content of the plant was significantly affected by the stage of growth, method of phosphate application and level of applied phosphate (Table 1). The stage and methods interaction was found to be statistically significant. Phosphate application either below the seed (3—5 cm below) or in contact with the seed proved significantly superior to broadcast application in improving the phosphorus level of the plant as mg/g material at all stages of growth, the higher level of phosphorus (60 kg P₂O₅/ha) being more effective. The phosphorus concentration as mg/g material of the plant at the 13 weeks growth stage was considerably reduced, suggesting that the phosphorus content of the plant decreases in the later stage of its growth.

Phosphorus derived from applied fertiliser. Phosphorus derived from the applied fertiliser was significantly affected by the mode of application, stage of growth and level of phosphate (Table 2). The stage and methods interaction was also significant. The response was significantly favourable when applied below the seed (3—5 cm below) or in contact with the seed, suggesting that the phosphatic fertiliser is better utilised when applied below the seed or in contact with the seed and that broadcast application is ineffective. The beneficial effect for the utilisation of phosphatic fertiliser was maximum when applied below the seed. The utilisation efficiency only improved due to the higher level of phosphorus (60 kg P₂O₅/ha) when applied below the seed, and it had little effect when applied in contact with the seed. The utilisation efficiency of applied fertiliser was comparatively low at the 7 weeks growth stage. Apparently, applied phosphorus is better utilised in the later stages of growth and its utilisation efficiency is unaffected in these later growth stages.

The present study reveals that the utilisation efficiency of applied phosphorus to pea crop is maximum at the 9, 11 and 13 week stages of growth, showing that more than 50% was derived from the fertiliser, and placement below the seed (3–5 cm below) proved to be the most efficient mode of application.

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MOSAIC DISEASE OF COCCINIA INDICA WIGHT AND ARN

Coccinia indica Wight and Arn. is a climbing or prostrate perennial herb, growing wild throughout India. Fresh fruits of *C. indica* are used as a vegetable. Various preparations of the roots, stems and leaves of *C. indica* have been mentioned in indigenous systems of medicine as being efficacious in the treatment of skin diseases, bronchial catarrh, bronchitis and diabetes. Last year, plants of this species growing in the campus of the Indian Agricultural Research Institute, New Delhi (India) showed a condition suggestive of virus disease. So studies were conducted to discover the cause of the disorder. The infected leaves showed a characteristic mosaic consisting of dark and light green islands. The leaves showed crinkling, puckering and a considerable reduction in the size of the leaves in instances of severe infection (Fig. 1). The present preliminary studies describe the symptomatology, host-range and transmission of the pathogen.

Sap transmission. Young diseased leaves of *C. indica* were crushed in a mortar and pestle, adding an equal amount (weight/volume) of 0.1 M phosphate buffer of pH 7.0 and the sap was extracted by passing the crushed leaves through a double layer of cheese cloth. The extracted sap was gently rubbed with the fingers onto the leaves of young healthy test plants dusted with carborundum powder of 600 mesh, grown in an insect-proof greenhouse. The inoculated plants were washed with water to remove the excess of extract and to avoid injury. The inoculated plants were observed for two months for the results.

Graft transmission. The diseased scions were grafted onto healthy stalks of *C. indica* in the wedge and cleft manner and the plants were kept in the greenhouse for observations.

Aphid transmission. Two species of aphids, namely *Aphis gossypii* and *Myzus persicae*, which have been reported to be efficient vectors of several plant viruses, were tested for the transmission of the pathogen. The aphids were given two hours of pre-acquisition fasting,

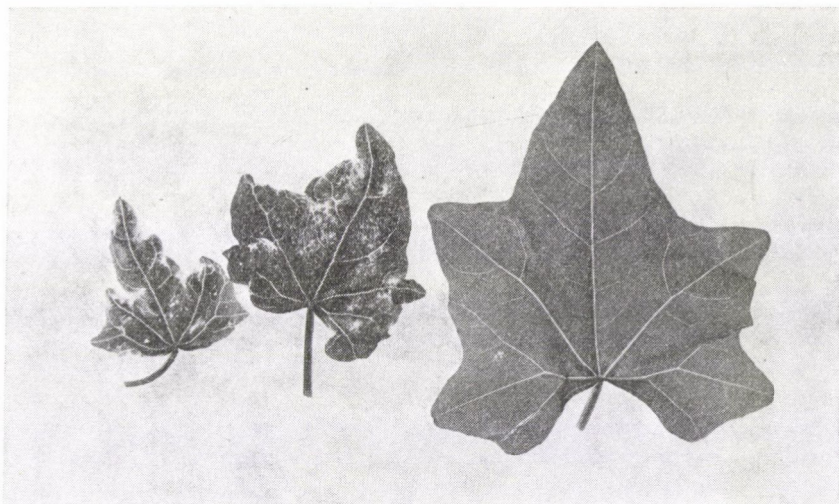


Fig. 1. *Coccinia indica* leaves showing mosaic symptoms. the leaf on the right is normal

followed by two minutes of acquisition feeding on the diseased leaves and 24 hours of inoculation feeding on *C. indica* plants. The insects were fed on the test plants in batches of 10 insects and were killed by spraying 0.001% Ekatox solution.

Whitefly transmission. The whiteflies were cultured on tobacco plants and were fed for 24 hours on the leaves of diseased *C. indica* plants in microcages. They were transferred to the test plants and were given 24 hours of inoculation feeding. The plants were sprayed with 0.001% Ekatox solution to kill the insects and the plants were kept in a greenhouse for observation.

The disease was not sap transmitted to the following plant species: *Achyranthes aspera* L., *Chenopodium amaranticolor* Coste and Reyn., *Coccinia indica* Wight and Arn., *Gomphrena globosa* L., *Luffa aegyptica* Mill., *Lycopersicon esculentum* Mill., *Peristrophe bicalyculata* Nees., *Nicotiana gluttonosa* L., *N. Tabacum* cv. Harrison's Special and White Burley.

Under the experimental conditions two species of aphids, *A. gossypii* and *M. persicae*, and the whitefly vector *Bemisia tabaci* failed to transmit the disease from *Coccinia* to *Coccinia*.

The disease could be easily transmitted by grafting from *C. indica* to *C. indica*, the incubation period being 20–30 days. The nature of transmission of the disease indicates that it is a virus disease. A perusal of the literature reveals that there is no record of any virus disease on *Coccinia*, so it is proposed to designate it "Coccinia Mosaic Virus".

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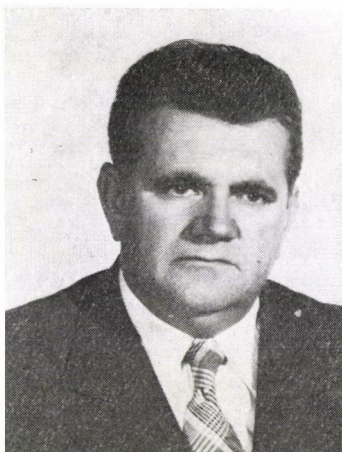
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Prepared at the Division of Mycology and Plant Pathology, Indian Agricultural Institute, New Delhi

V. S. VERMA, S. SINGH, R. PADMA

FORUM

OUR GUEST IS



ISTVÁN SZABÓ

PRESIDENT
OF THE NATIONAL COUNCIL OF CO-OPERATIVE FARMS

PÁL, GY.: Mr. President!

In Hungary today the proportion of the work-force exclusively engaged in agricultural work is well below 20% on a national scale. And the proportion of village people for whom agriculture is a full-time occupation has probably fallen below 40% by now. Owing to the low standard of supplies in small settlements, a large number of industrial workers are moving away, leading to the depopulation of some villages. For instance, some 68% of the population has left Tornakápolna (Borsod county) over the last ten years. Do you think that the existence of household plots and subsidiary farms might check the undesirable depopulation of small settlements?

SZABÓ, I.: I think that to draw such a parallel between the two phenomena is to oversimplify the causes of depopulation and overestimate the existence and role of household plots and subsidiary farms. An important component of Hungarian agricultural and co-operative policies is the joint development of large-scale enterprises and subsidiary farms, of modern and traditional production methods and of diversified organizational forms suitable for them. Relations between the collective farm and the household plots are exemplarily organized in many co-operative farms.

It must not be forgotten, however, that despite certain advantages of small-scale production, the large farms have priority. The main income of the people concerned does not come from the household plot, but from the collectively organized work, and this is simply complemented by the income obtained from household plots

or small-scale production. Today this sum can be considered as a payment for the surplus work done at the expense of leisure time.

In general, household plots and subsidiary farms cannot be discussed in isolation. It is the large farm that forms the basis of their existence. Without its support there would be no production of this kind! In my experience, in small settlements where well-managed farms or other farming organizations function people have ceased to move away.

The nature of the settlements, the standard of supplies, and the social and cultural conditions of country life depend greatly on the jobs offered by local farming organizations. The question can only be considered in this light, and there is no justification for regarding the opportunity to carry out surplus work at the expense of leisure time as a determining factor.

Thus, it is the simultaneous presence of numerous components of village development which may reduce the likelihood of depopulation, rather than the possibility of household plot and subsidiary farming. The co-operative farm, as I have already said, may be one of these determining factors, but the possibility of either household plots or subsidiary farming definitely does not belong in this category. It may strengthen an existing attachment to the small settlement, but is not sufficient to form such an attachment, as it can never satisfy the demands raised by the inhabitants on their environment.

*

PÁL, GY.: *The production from household plots and subsidiary farms makes up more than a third of the gross agricultural production of Hungary. In these farms, production is basically designed for the personal utilization of the labour force and is directly controlled by the requirements and the market. These farms mobilize a great deal of labour and increase the total number of hours spent working (pensioners, family members, school children, women on maternity leave). In your opinion, is working in household plots and subsidiary farms a form of recreation in Hungary, or it is rather a necessity, at the present level of agricultural development, in order to supply the population properly with food?*

SZABÓ, I.: Without wishing to repeat myself, I should like to emphasize once again that for the last twenty to twenty-five years Hungarian agricultural policy has always counted on the produce of household plots and subsidiary farms. This conclusion must be drawn whether development is considered from the point of view of self-sufficiency, commodity production, or personal incomes. A good example of this basic policy is the clause laid down in law: "the household plot is the subsidiary farm of co-operative farm workers, aimed at satisfying the household requirements of these workers and their families and increasing their incomes. The household plot may also be used for commodity production. The household plot is an integral part of the collective farm, working in close co-operation".

The passage quoted above reflects a rational consideration of Hungarian agricultural conditions, of the fact that subsidiary farming is a traditional and well-exploitable part of country life. It is, indeed, a valuable form of recreation. It is not a necessity in the sense that without this activity the public could not be properly supplied, but it is a fact that household plot farming is still an integral part of the agricultural co-operative movement. The cost to society of products produced and consumed here, and of the commodities produced, is in many cases lower than for the products of large farms. But let there be no misunderstanding: this does not mean that small-scale commodity production is superior to large-scale production; on a

small-scale basis only a fraction of the present volume of goods could be produced, and in some cases none at all. Household plot production makes use of an otherwise inutilizable labour reserve. The production bases of these subsidiary farms are mostly the remnants of previously liquidated small-scale farming activities. And what is very important: they have been resuscitated with the personal savings of the individuals involved.

*

PÁL, GY.: *The large farms carry out the production of plant species giving large yields (wheat, maize, sugar-beet, sunflower), while the labour-intensive horticulture and livestock breeding have been left to the small farms. In the small farms the production of 100 litres milk takes 1.8—2.0 times as long, and that of 100 kg pork or beef 2.2—2.4 times as long as in the large farms on average, while horticultural work is still more time-consuming; therefore, even the small farms are beginning to show signs of becoming extensive. In your opinion, are the existence and extent of household plots and subsidiary farms determined by the size of income obtained by a family from this production or by the age composition of the family?*

SZABÓ, I.: I will restrict myself to discussing the household plots of co-operative farm workers. It should be made quite clear that the existence and extent of subsidiary farming depend fundamentally on the co-operative farm. It has not been mentioned so far that the maintenance of a household plot depends not only on whether the person concerned is a member of the co-operative. Members are only entitled to a household plot if they have fulfilled their duties in the collective farm, as laid down in the legal and constitutional regulations.

It is thus only in this light that we can speak of the existence and extent of household plots and examine the motives for this subsidiary farming activity. Nearly half of those farming on household plots produce goods almost exclusively for their own consumption; the farm-work is done to satisfy the family requirements and is an inseparable part of their way of life; they rarely take goods to market.

Again nearly half the household plot producers are involved in market operations, involving either a greater or lesser extent of personal investment, or making use of the credits granted for the support of small-scale production. Naturally this activity is not undertaken alone, but with the co-operation of the family. Furthermore, commodity production of this character is carried out on the basis of bilateral agreements made with production or consumption co-operatives, or with marketing or purchasing organizations. In this case there is also a certain degree of specialization. It is a characteristic feature of this kind of household plot farming that it is mostly undertaken by country families where several generations live in the same household.

Mention should also be made of a very small, labile group whose members farm on a scale exceeding the socially accepted framework of household plot and subsidiary farming and employ labour in addition to the family.

I think this classification, which probably gives an adequate picture of the present situation, demonstrates in itself what the motives are.

*

PÁL, GY.: *In Hungary co-operative farm workers and members of industrial co-operatives have household plots, while non-agricultural workers and pensioners have subsidiary farms. Half the population, i.e. more than 5 million people, take an active part in these farms.*

Nearly half of them are pensioners and 52% of the proprietors belong to the working class. From a health point of view these farms reduce the time devoted to rest, while from a cultural point of view they reduce the leisure time. Do you think the number and productivity of household plots and subsidiary farms should be increased at the expense of leisure time, even if this is in the interests of the national economy?

SZABÓ, I.: The question seems to suggest that the number and production rate of household plots and subsidiary farms is dictated! This is by no means the case! Everybody decides for himself whether to do productive work or to ask for the counter-value from the co-operative. This decision is determined by the incentive role of the supporting system and by the willingness of the individual or family to undertake it. Unfortunately, household plots are sometimes farmed at the expense of rest and leisure time, but not on a large scale and not permanently, even within a given farming year. Obviously a person will give serious consideration to how he spends his remaining strength and time. The burden is naturally reduced by the fact that household plot and subsidiary farming is mostly a family affair, with a certain division of labour.

Of course, the tension mentioned cannot be denied. One thing must not, however, be forgotten, even if it is not directly connected with the question; this work may lead to the improvement of professional knowledge and skill, which is not a matter of indifference. Furthermore, the social demands of co-operative workers do not lag behind those of other groups and strata of society. They feel the need for well-organized holidays and cultural programmes just as other workers do; at most, the different character of country life and cultural possibilities, and the differences in personal requirements have some influence on the way leisure time is spent.

*

PÁL, GY.: *The area taken up by household plots and subsidiary farms is constantly on the decrease; it was 1,254,000 ha in 1976–1979 and 1,567,500 ha in the previous five-year period. In spite of the fact that the income per hour of those working in these farms is lower than that of industrial workers, the role of self-sufficiency in these farms is decreasing and the volume of commodity production is increasing. In your opinion should those workers who want to give up their household plots or reduce their production be persuaded of the importance of household plot farming, or should more support be given to those who wish to establish new farms or increase the productivity of the existing ones?*

SZABÓ, I.: It is not only in crop production that household plot farming is involved; it plays a role in livestock rearing as well. I should not speak of persuasion in any of the categories mentioned, nor is the assistance given by the co-operative farm to the household plots of its members of this nature. If there is willingness on the part of the members, the co-operative management regards the household plot as an integral part of the co-operative, for which the production and marketing conditions must be created primarily by the collective farm. I should like to mention as an example the "Vörös Csillag" (Red Star) Co-operative Farm at Nádudvar, my own co-operative farm: 2800 families have household plots and 1110 of them produce agricultural products such as slaughter animals and milk which broaden the range of commodities available. And this is not the result of persuasion, but of creating favourable conditions for those concerned in livestock farming on household: we sell fodder and breeding stock, help with selling and transporting, naturally in exchange for payment, and give expert

advice. In the view of our members and others, which coincides with the views expressed in the agricultural policy, the personal and family incomes are derived chiefly from work done in the collective farm, rather than from the household plot. The disquieting thing would be if this was lower than the income of industrial skilled workers. The difference in income level between industrial and agricultural workers has become very small, and this is extremely important. This is the determining factor, and not whether the extra income obtained for work done as a family after working hours is equal to or proportionate with other peoples' incomes.

*

PÁL, GY.: *The socialist large-scale farm, of which the household plot and the subsidiary farm are integral parts, utilizes not only its own material and intellectual bases (buildings, implements, production experience, professional knowledge) for specialized, highly productive commodity production, but also those of the household plot and the subsidiary farm. More than a quarter of the gross stock of fixed assets available to agriculture form the property of household plots and subsidiary farms. Furthermore, the large farm employs the free labour available in the neighbourhood too (pensioners, family members, dependants) Do you think that the integrated household plots and subsidiary farms will be able to draw off the extra labour force which is causing in-plant unemployment in industrial establishments?*

SZABÓ, I.: To begin with, those who work in industry, for example, also have subsidiary-farms, since hobby gardens, closed gardens in personal possession, and holiday plots can also be regarded as such. Secondly: country families cannot be divided into co-operative farm workers' families and families which work in industry. More than half the industrial workers live in the country. When speaking of household plots and subsidiary farms these facts must be taken into consideration.

In my opinion the household plot and the subsidiary farm do not represent such a great attraction, as they are secondary "jobs", and the income derived from them, or the products which improves self-sufficiency, are also only secondary.

Much more can be said about the attraction of the large-scale farm, the co-operative farm, since the large-scale production and income of collective farms with high or medium productivity offer good job opportunities either on the farm itself or in the industrial or servicing activities. This is naturally a matter of coinciding interests rather than a withdrawal of labour.

*

PÁL, GY.: *Accommodation for 1.3 million cattle and 5.5 million pigs, and poultry-houses covering more than 4 million m² are to be found on household plots and subsidiary farms. The value of these establishments is 24 thousand million Ft, equal to the total sum of agricultural investments in a five-year plan period. Nevertheless, only 371,000, 364,000 and 347,000 cattle were kept on the household plots and subsidiary farms in 1976, 1977 and 1978, respectively. Of these the number of cows was 180,000, 176,000 and 174,000 respectively. Do you think that as a result of reurbanization, of moving back to the village, a better utilization of animal housing can be expected in the household plots and subsidiary farms?*

SZABÓ, I.: Well, I am no prophet, but it may happen that we shall be witnesses to such changes. However, the process of reurbanization is not a determining factor in this respect; other conditions are also required. For instance, a sufficient force of integration, which is only present in a large-scale farm or a consumer co-operative; personal interest and incentive are not dispensable either — this must not be forgotten.

*

PÁL, GY.: *In Hungary 70—75% of families have a certain amount of income from household plots or subsidiary farms. For every second of these families this surplus income brings their total family income up to the national average, while only one family in every ten thousand achieves an outstandingly high living standard. Incomes derived from household plots and subsidiary farms thus have an equalizing rather than a differentiating effect. In your opinion do household plots and subsidiary farms have a higher capacity for population sustenance than the socialist large farm, in the same way as the small holding had under capitalism?*

SZABÓ, I.: I think my previous answers have made it clear what the role of the household plot and subsidiary farm is, what the conditions for their existence are, and how they influence personal or family incomes. Neither need further evidence be given of the fact that it is not from the household plots that the co-operative farm families live. The large farms are the main providers of food for the population of Hungary, and this is simply complemented by the household plots and subsidiary farms, which are integrated by the cooperative farms.

The household plots are rooted in and supported by the large farms; only when linked to them can they yield socially useful results. The wages earned for work on the collective farm make up the major part of the incomes of co-operative farm workers, and thus determine the material and cultural welfare of the farm population. Under the social, cultural and infrastructural conditions of the given settlements, the ability to supply the population is naturally only possessed by the large farm, the co-operative.

*

PÁL, GY.: *Lenin writes: "The hard-working peasant as a central figure of the economic boom". And in his study of "Tax in kind" he says that the small commodity producer will not become a capitalist, but a promoter of socialism, if capital and landed property cannot be accumulated, i.e. if the political and economic power are in the hands of the working class. In your opinion, which type of household plot or subsidiary farm is most likely to become a capitalist commodity-producing farm: those with mixed production (vegetable and fruit growing, poultry, pig and cattle rearing all in one farm) or with specialized production (vegetable growing, poultry rearing, etc., alone)?*

SZABÓ, I.: Capitalist commodity-producing farm? I do not understand how this question can arise at all! Household plot farming is carried on with the support and organization of the socialist large-scale farm. This activity is based on the individual work of the co-operative farm worker or his family. The assets used do not exceed in size or value those usual for personal property, and originate from the work of the co-operative farm worker, not from the exploitation of other people. Most of the household plot products are marketed or processed by the integrating large farm. It is not the main source of income for the co-operative farm workers, as I have mentioned already.

In short: under the conditions in Hungary, household plots belonging to neither category can become capitalist commodity-producing farms.

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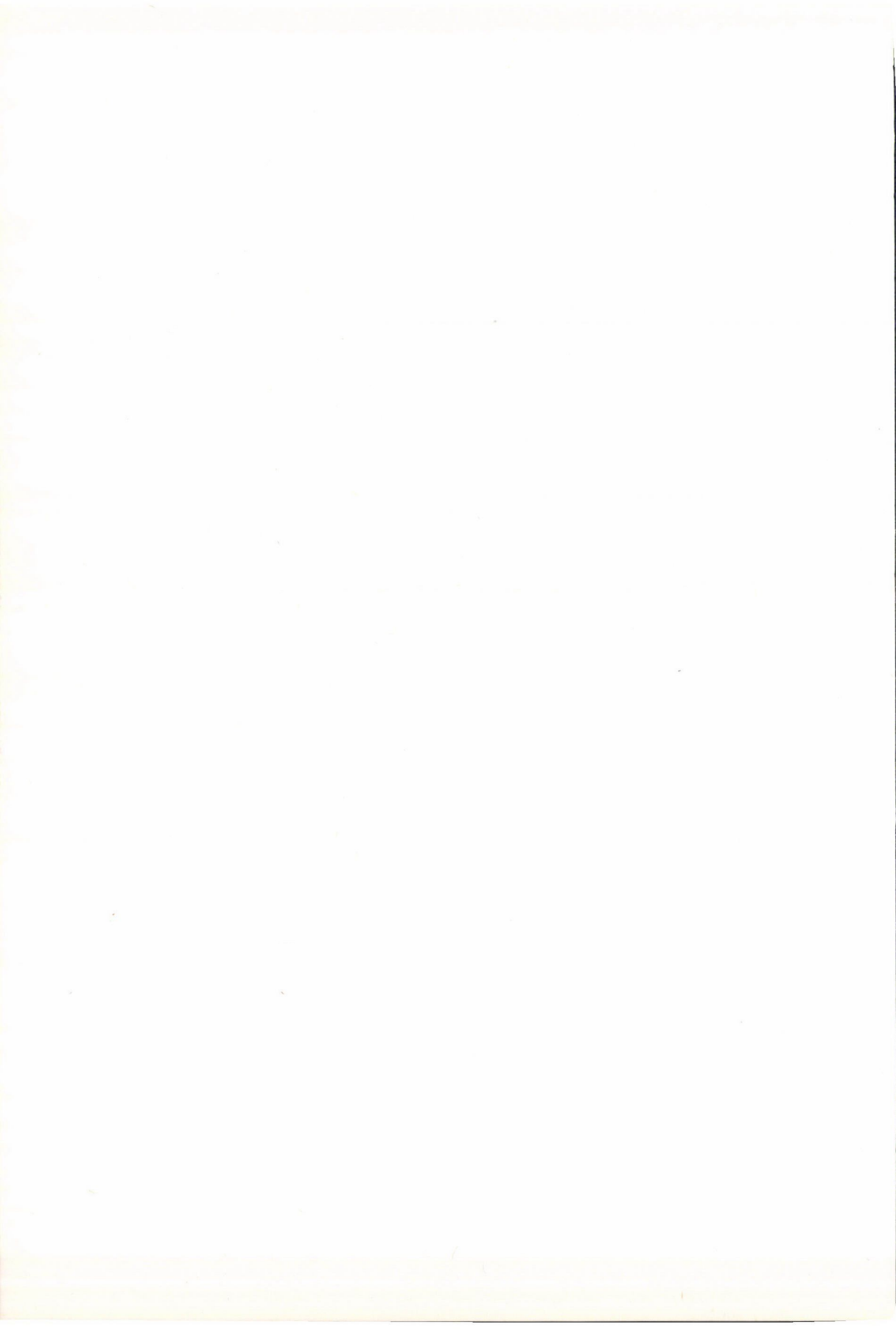
PÁL, GY.: *The labour shortage is today a phenomenon affecting not only the large farms but the household plots and subsidiary farms, and can only be counterbalanced by raising the level of mechanization. In Hungary a Rába-Steiger Tougat II tractor costs 1,194,600 Ft and a Zetor-120/45 tractor 505,535 Ft, while the price for a fully equipped T.4-K.14.B is 93,200 Ft. As President of the National Council of Co-operative Farms, do you think the agricultural price gap is larger for the tractors used in the large farms or for the implements employed in the household plots and subsidiary farms?*

SZABÓ, I.: This is a difficult question to answer as no data from this kind of survey are available. On the basis of my own experience I think the agricultural price gap is larger in the case of the large farms. Tractors are purchased with state subsidies, and they really are becoming more and more expensive, but this cannot be passed on in the prices of our agricultural products.

What is the situation in the homeplots? They use garden cultivators and attachments belonging to the free price category, generally obtained from capitalist import, mainly for vegetable and fruit growing. These products are sold at free prices, so the agricultural price gap is narrower here. This question naturally arises only when the fruit and vegetables are taken to market. For crops grown as a hobby, or for consumption, nobody is likely to be concerned about the price gap.

*

PÁL, GY.: *Thank you for the information.*



CHRONICA



PRINCE MIKLÓS ODESCALCHI*

(1902-1945)

Historical truth demands a fair evaluation of the activities of forces, groups and persons who, while not directly progressive or explicitly left-wing, have nevertheless played some role in the history of the nation. Those who participated in the antifascist struggle deserved to have their names rendered immortal and their deeds appreciated, irrespective of their former social status. Prince Miklós Odescalchi, with his eccentric way of life and tragic end, was one of these persons. His name, personality and the social order of his times have — until recently — prevented researchers on the subject from mentioning him, perhaps not primarily because he was a prince, but because his short life was full of contradictions and because few data are available. A person with the manners of a highly aristocratic family, who often put on airs and graces like the lord of a castle in the Middle Ages, has never been a popular research subject, particularly in the 1950s, when the writing of history was centrally controlled.

The life of Miklós Odescalchi is a subject best suited for the pen of a belletrist. That it is dealt with in a professional paper is due to the role this extravagant Bohemian aristocrat,

* The portrait of Miklós Odescalchi is the work of Mórícz Gábor. The drawing is reprinted by kind permission of the artist.

The Editors

whose political views were difficult to define, played in the agonizing events of the last months of World War II.

His "conversion" does not require any forced interpretation. Respect for family traditions was presumably not a decisive factor, since Odescalchi did not bother much about conventions; it was an anti-German manifestation rather than anything. One fact of a personal nature which should not be overlooked is that his first wife was the divorced wife of an important official at the German legation in Hungary. Odescalchi divorced her for unknown reasons, so this does not necessarily have any bearing on the subsequent course of his life. The family's business relations with Germany are not known in detail. We do know, on the other hand, that he gave voice to his anti-German feelings during the war, in preparation for changing sides. Perhaps the anti-German groups active among the highest aristocracy, and Miklós Horthy Jr., head of the "Desertion Bureau", secretly organized in the Buda Castle in 1944 and dealing with the question of an armistice, had something to do with this.

The question is, whether he was anti-German or anti-fascist — or both. It is a well-known historical fact that a large proportion of the aristocrats did not sympathize at all with the national socialist ideology, and were particularly disdainful with respect to Hitler and his followers. Odescalchi shared this view.

As a member of a family which had carried out successful farming activities, including the introduction of new crops, for a long time, Odescalchi definitely played a role in the agriculture of Hungary, even if he himself did not do much farming. His role in public and social life and his short military career will be judged by history.

It was not by chance that in 1945 two martyrs, each of whom had had a singular vocation, were exhumed at Sopronkőhida. Both were given the last honours, promotion and a ceremonious military funeral in Budapest, after which both were forgotten. These two persons were Endre Bajcsy-Zsilinszky and Miklós Odescalchi.

The ancestors

The present paper is not intended as a genealogy, yet it is indispensable to dwell on this subject at some length, since the historical background of Odescalchi's ancestors on both sides is extremely interesting, and not only from the family point of view.

Sources encountered here and there agree that the Odescalchi family is of Italian origin. Their first known ancestor, Giorgio, lived around 1290. He came from a wealthy family of bankers well known in Como, a town in Northern Italy, where the family had its ancestral residence. Several members of the family held high office in the service of the church in the 16th century. Gyula occupied a post in the court of Pope Pius V; it was he who conveyed the Pope's Apostolic benediction to the Christian fleet before the battle at Lepanto. During the same period, Bernard was famous in the Society of Jesus for his extreme piety. He was the papal legate to Poland under Pope Gregory XIII, and as such won King István Báthory's confidence; later he appeared in Transylvania as a zealous propagator of the Catholic religion.¹

The name most frequently mentioned in the history of the family is that of Benedek Odescalchi (1611—1689), who is recorded in the history of the Catholic Church as Pope Innocent XI.

The reign of Pope Innocent XI was closely connected with the history of Hungary. Most of his efforts were aimed at the liberation of Christianity. He attempted to bring about a reconciliation between the Christian powers, so that they should concentrate their forces in a war of liberation against the Turks. His diplomatic services and the large sums sent to the papal nuncio from the treasury of the Holy See for the purposes of the war against the Ottomans, put the Hungarian nation under a deep obligation. He brought about an alliance between Leopold, Emperor of Austria, and Jan Sobieski, King of Poland, which resulted in the liberation of Vienna (12th September 1683), a victory at Párkány (28th October), and finally in the retaking of Buda in 1686. When Leopold learned of the death of Pope Innocent XI he made Livius Odescalchi, the Pope's nephew, a prince of the Holy Roman Empire, then endowed him with the principedom of Syrmia, which is situated in region of Hungary liberated after 150 years of Turkish occupation largely due to the efforts of his uncle.

It should be noted here that the day on which Buda was retaken (2nd September) was ordered by the Pope to be celebrated throughout the Catholic world as the feast of St.

¹ The most accurate history of the Odescalchi family has been written by Sándor Erba Odescalchi. In his work entitled *XI Ince (Innocent XI) 180 sources are given and the relevant material from 8 archives are published in the bibliography appended to the book.*



Odescalchi in the Mátyásföld airfield some time after 1930



Fig. 1. The Odescalchi castle in the 1970s

Stephen, first king of Hungary, in eternal memory of the victory over the Turks. The S. Rituum Congregatio sent its resolution on the subject to Leopold on 14th December 1686. The Catholic Church has celebrated the feast of St. Stephen on 2nd September up to the present day, with the exception of Hungary where, in accordance with the old tradition, it is celebrated on 20th August.

The history of the Odescalchis in Hungary began with Livius, the Pope's nephew. Pope Innocent had seven brothers and sisters. Livius, who was born in 1654, was the son of Károly. In his person the family became patricians of Venice; in 1696 he bought Bracciano, a locality beside the former Via Claudia, and was at the same time granted the titles Duca di Bracciano and Duca di Ceri; at that time he was already in possession of the titles Conte di Montiono and Marchese di Roncofredo. Thus, on 29th August 1689 Livius and his descendants of both sexes were raised to the rank of Prince of the Holy Roman Empire, and on 21st August

1697, when Leopold conferred the title Prince of Syrmia on him, this was extended to Hungary. It is perhaps worth mentioning that in the meantime he became a class I Spanish grandee.

Finally, on December 11th 1698 the principedom of Syrmia was granted to him with the privilege that, if he had no direct descendants, he should be allowed to adopt a member of his family. Being childless he soon made use of this privilege and on 13th May 1709 adopted Marquis Boldizsár Erba, son of his aunt Lucretia, wife of Sándor Erba. On 20th March 1714 he received imperial authority to confer his principedom on him. The principedom of the Odescalchi family was thus transferred to the Erba family, and Boldizsár Erba-Odescalchi became the ancestor of the subsequent Odescalchis. Livius, who was endowed with the principedom of Syrmia, died on 8th September 1913.²

Livius, son of Prince Boldizsár (Erba) Odescalchi (who died in 1746), made an application to the Diet for the granting of indigeneity. This the members of the Diet granted him, emphasizing in the Act (1751: 40) passed on that occasion "the extraordinary merits of His Holiness Pope Innocent XI in fighting down the enemy of Christianity through his incessant solicitude and his powerful contribution to the requirements of war". (His indigeneity and oath: Vienna, 6th April 1751.)

Space does not allow the presentation of a genealogical table, so we must confine ourselves to giving a few data on the family. Ince Odescalchi, born on 22nd July 1778 in Rome became Imperial and Royal chamberlain in 1801; he was also a knight of the Order of Christ and Lord Steward to the queen, and died on 23rd September 1833. For Hungary his name became memorable in 1808 when he endowed 5000 Forints to the "Ludovika" military academy. Sándor obtained Hungarian nationality on April 8th 1831.

Ince married twice and had five children: Livius, Ágost, Paulina, Viktoria and Viktor. In the present case Ágost, the second child, is the most important; he was born on 1st May 1808 and died on 15th October 1848. He married Countess Anna Zichy on 18th November 1827 in Pozsony. From this marriage were born Gyula (26th November 1828, Pozsony), and Artur, Miklós Odescalchi's grandfather.

Gyula Odescalchi was hardly 20 years old when he took part in the war of independence as a lieutenant in the national guard in the county of Nyitra. After the collapse of the Hungarian forces he went to Switzerland with his family and only returned in 1850. From the 1860s onwards he was a member of Parliament several times: in 1861, 1865, then in the 1875—78, 1878—81 and 1881—84 sessions (in the last session his younger brother, Artur, was also a member). He was a perpetual member of the Upper House. One of the very first Hungarian cultural societies, the Public Education Society of Upper Northern Hungary, organized in 1881 at Nyitra, held its first statutory meeting on 20th November 1883 with Prince Gyula Odescalchi as chairman. He died in October 1895.

Artur Odescalchi, the grandfather, seems to have been a more colourful personality. He was born at Szolcsány on 24th July 1836, attended school in Pozsony and completed his studies at Leipzig University. He spent a considerable length of time in Switzerland and Italy. He was a captain in the Royal Hungarian Army and at the same time the commanding officer of the Nyitra battalion. He was elected member of Parliament for Tapolca in 1881 and for Vág-Vecse in 1886, first with an independence programme and then as a non-party candidate. He was Imperial and Royal chamberlain, Knight of Malta, member of the Upper House, director and committee member of the Hungarian History Society, the Hungarian Archeological Society and the Hungarian Heraldical and Genealogical Society, an honorary president of the Public Education Society of Upper Northern Hungary, etc. He published a number of

² The Hungarian nobility had four grades: gentry, barony, countship and principedom; those belonging to the latter three groups (barons, counts, princes) were called aristocrats. They did not form a separate class; their ranks were the higher grades of the nobility. The title of prince for persons unassociated with the royal family first occurred in Hungary in the 15th century, as the title of Lőrinc Újlaki, Prince of Syrmia. Princely families with the right of perpetual membership of the Upper House of Hungary were: Auersperg, Batthyány-Strattmann, Czartoryski, Esterházy, Khevenhüller-Metsch, Kinsky, Lemberg, Liechtenstein, Lobkowitz, Metternich-Winneburg, Odescalchi, Pálffy, Schwarzenberg, Thurn-Taxis, Trauttmansdorf and Windisch-Grätz. As a matter of fact, only three of these were Hungarian: the Esterházy, Batthyány and Pálffy families. Furthermore, it should be noted that of the princely families regarded as indigenous in Hungary the Odescalchis were not mediatized. Mediatized families are those which, from the point of view of marriage, fall under the same category as the ruling families, and marriages between their members are acknowledged as equal in rank even by the ruling families. (The Italian nobility has the following grades: principe and duca = prince; marchese = marquis; conte = count; barone = baron. Patrician families are those closely connected with the history of a town.)



Fig. 2. Odescalchi with his famous horse before a show-jumping competition in around 1935

papers on Hungarian historical subjects in *Századok* (Centuries), *Történelmi Tár* (Historical Collection) and other historical periodicals, and wrote several books under the pseudonym Szerémi.

He lived a romantic life. In the words of Zsigmond Justh: "... Artur is an extremely simple person, someone who takes his principedom seriously and thinks he lives in the age of chivalry under a cloak of ermine. He adores archeology, numismatics and heraldry; he knows how many ancestors each man in Hungary has and whom he is equal in rank with. In addition, he is thrilled to think that he lives the life of an old-time knight, or feudal lord."

His family life was not dull either. His first wife, Baroness Eugenia Lo Presti, whom he married on 27th August 1862 in Pozsony, died on 28th June 1866. His second wife was Countess Valéria Erdődy, whom he divorced. On 10th January 1876 he married Countess Júlia Zichy at Kolozsvár, but he was later divorced again. His children were: Livius, Loránd, Jenő Zoárd, Edua, Alinka and Galma. The third child, Jenő Zoárd, was born from his third wife.

Jenő Zoárd Odescalchi was born on 9th October 1876 at Bolhás, Somogy county. There are few data on him. He was a perpetual member of the Upper Hoxse, at a time when the Upper House had eight princely members, including Géza Odescalchi, reserve second-lieutenant in the Hungarian light cavalry, a cousin of Jenő Zoárd.

It is unknown how the 21-year-old prince became acquainted with Pálma Lónyai, the beautiful daughter of the Lónyays of Bereg county. Love led to marriage. At that time the bride's father was already dead, and her brothers and sisters had all died in their early childhood.³ The wedding took place on 8th June 1901 at Tuzsér.

On the mother's side the Lónyay family played perhaps a more important role in the historical past of Hungary than the Italian family with a pope among their ancestors.

The first Lónyay ancestor known from authentic sources was the son of Nána Berenthei, Count Jakab, whose second wife, after 1278, was the daughter of Count Kozma of the Hunt-Pazman family, widow of Mihály, son of Endre of the Rosd family. With his new marriage he became the proprietor of the Lónyay estate which then consisted of two villages of Lónya and the villages of Bótrágy and Bátoru in Bereg county and Szalóka in Ung County. As the landed property of Mihály, son of Endre of the Rosd family, who died without male issue, it was granted by King László IV to the widow and her second husband, Jakab Berenthei, in

³ See the register of births, marriages and deaths in the Presbyterian Church at Lónya. In the cemetery at Lónya 28 Lónyays lie at rest in the family vault. The twenty-ninth was brought home from Komárom county in November 1981.

1285, and through them to Pousa, the son born to Jakab from his first marriage, and to Benchench, Jakab and Miklós, the sons born from this second marriage. The descendants of Master Jakab later became the Naményis, while those of Master Benchench became the Lónyays, who were later raised first to the rank of baron and then made counts. Barony was obtained by Zsigmond I, son of István, captain of Szatmár and Tokaj, and Katalin Báthory (Szaniszlóffy), who was already a landed nobleman on the Báthory right, and a diplomat who played an important role in concluding the peace treaties of Pozsony and Linz. He was Lord Lieutenant of Kraszna county in 1627 and of Bereg county in 1648, and a candidate for the palatinate in 1649. In 1627 he was made a baron by Ferdinand II. Of his daughters, Anna was the wife first of István Wesselényi and then of János Kemény, Prince of Transylvania; Margit was the wife first of István Telegdy and then of Count István Csáky; and Zsuzsánna was the wife of István Bocskay, Lord Lieutenant of Zemplén county; he left no male descendants.

One of the most prominent members of the Lónyay family was Menyhért Lónyay of Nagylónya and Vásárosnamény, who was born on 6th January 1822 (according to another source, on 4th June 1824) at Nagy-Lónya. In his youth he was a county official; he was elected as deputy in 1843 and as people's representative in 1848, when he was also appointed state secretary. From 1867 to 1869 he was Royal Hungarian Minister of Finance, in 1870—1871 Austro-Hungarian Minister of Finance, then for a short time Prime Minister. In 1871 he was made a count.⁴ He was a publicist who wrote several economic and scientific works. The drainage and canalization of marshy areas in the Nyírség (northeastern Hungary) and the regulation of the upper reaches of the River Tisza are associated with his name. He was a Privy Councillor, a Knight of the Order of Leopold; from 1858 a corresponding member, in 1866 vice-president, then president of the Hungarian Academy of Sciences; and member of Parliament for Tiszahát. On 20th September 1845 he married Emília Kappel (11th January 1825—20th October 1888), the daughter of Frigyes Kappel, a rich banker of Pest, whom the poet Petőfi once saw in the theatre and proposed marriage to in a fit of youthful enthusiasm.

Menyhért II, Miklós Odescalchi's maternal grandfather, was born on 20th August 1849 at Pest, and married countess Margit Forgách on 16th July 1873 at Alsó-Kemencze. After her husband died in Abbazia on 8th March 1887 Margit Forgách (born 3rd March 1851) remarried at Mándok, Szabolcs county, on 24th May 1890. Her second husband, Tivadar Salamon, from Alap, died on 14th April 1899 at Tuzsér.

From the marriage of Menyhért Lónyay and Margit Forgách four children were born: István Kálmán (16th April 1874—6th November 1874), Anna Emília (26th July 1875—29th September 1879), Mária Erzsébet (24th March 1877—13th May 1880) and Pálma Eleonóra Vicentina, Miklós' mother, born on 25th March 1880 at Nagy-Szalánc.

Here some mention must be made of the Forgách family, of which the Lónyays and Odescalchis were very proud. According to the chronicle of Simon Kézai, the ancestors of the Forgách family were Hont and Pázmán, two armoured warriors of Swabian origin, who, together with other warriors, wished to go on an overseas pilgrimage, but Géza, Prince of Hungary retained them at his court; later, the brothers girded St. Stephen, first king of Hungary, with a sword by the river Garam, according to a German tradition. The first Forgách ancestor on the Ugocsa branch of the Huntpazman clan was Count Ivanch at the end of the 12th century, whose son Ivanka (Joanka) was given the land of Gumes (Gimes, Nyitra county) by King András II some time before 1226. Ivanka's son András, Count of Bana, extended this land through a further donation in 1253 and by purchase in 1264, and between 1253 and 1270 built a fortified castle, later known as Gimes castle but then called Divénykő (Dyvenkuy). From then on the family used the name Ghymesí.

Of the sons of András, Count of Bana, Tamás was Count of the royal treasurers in 1278 and Lord Lieutenant of the counties of Nyitra and Bars in 1295; by marrying into the baronial Bebek family his younger brother Miklós Forgách ensured his descendants a place in the royal court. Of his grandchildren, Balázs was cup-bearer to the queen from 1383 until his death on 25th July, and played a leading role with his associate Miklós Garai in the assassination of Anjou Charles II. It was he who dealt the mortal blow on 7th February 1386, in return for which Gimes Castle, which was lost to the family in 1300, was returned to him by Queen Erzsébet, widow of Lajos the Great, and Queen Mária. Balázs' brother Master János was page to the queen, as was his cousin András' son Péter, who later became sub-prefect of Pozsony (1398—1400), Lord-Lieutenant of Nyitra (from 1401), then chief sergeant-at-arms to the queen. His grandson Gergely, sub-prefect of Nyitra (died 1515) founded the Gács branch

⁴ The Lónyay family has two branches. The older one (Gábor-branch) was raised to the rank of Hungarian counts on 29th October 1896, while the members of the younger (Menyhért) branch were made Hungarian counts on 3rd August 1871.



Fig. 3. In the Mátyásföld airfield, some time after 1930; from left to right: Dr. József (Habsburg) royal prince, Miklós Odescalchi and Archduke Albrecht in a touring competition

of the family. His son Zsigmond, royal treasurer, became baron in 1560; among the children born to him from his wife Katalin Zólyomi, Simon (1527—1598) was one of the most prominent Hungarian military leaders of the 16th century, while his younger brother Ferenc (1530—1577) was a learned humanist historian, bishop of Várad, and later chancellor to István Báthory. Among the children of Simon and his wife Orsolya Pemflinger, Zsigmond (approx. 1559—1621) was a royal councillor, first cup-bearer to the king, later Lord Chief Justice, captain-general of Upper North Hungary and finally Palatine of Hungary, leader of the unsuccessful military expedition against Transylvania in 1611; his younger brother Ferenc (1566—1615) was a cardinal, archbishop of Esztergom, one of the leaders of the counter-reformation in Hungary, who in addition to his primateship, also held the office of royal governor. Ádám (1601—1681), son of Zsigmond and his wife Zsuzsánna Thurzó, was the captain-general first of Szécsény, then of Kassa, Érsekújvár and the region between the rivers Danube and Tisza. From 1670 he was Lord Chief Justice and in 1640 was raised to the rank of count. One of his sons, Simon (1669—1730), was first an imperial company officer, then fieldmarshal in the “Kuruc” army (fighting for independence under the leadership of Thököly and Rákóczi). He published Miklós Zrínyi’s “Török Áfium” with a preface to Rákóczi (Kolozs-vár 1705), and died as an exile in Zulawa, Poland.

Following the descent of the family, almost all the prominent families of the Hungarian aristocracy, such as the Thuróczy, Balassa, Dobó, Perényi, Zrínyi, Segnyei, Gyulaffy, Apponyi, Pálffy, Széchy, Csáky, Révay, Batthyány, Zichy, Esterházy, Nádasdy, Andrassy, Péchy, etc. families can be found among the partners in marriage, many of whom upheld the banner of progress in the course of the centuries. These deeds and traditions undoubtedly served as a model for Prince Miklós Odescalchi. What he learnt from these historical examples was attested by his life.

The birthplace

Tuzsér is a village in Szabolcs county, in the Tisza (now Kisvárdai) district, in the Tisza Bend; at the turn of the century the number of inhabitants was 1500—1600. The first known proprietor was Renold, Lord Chief Treasurer, ancestor of the Rozgonyis, who received it as a royal gift in 1270. Three years later the king confirmed him in his possession. In the 14th century Tuzsér passed into the proprietorship of the Váradis. In 1712, with the consent of the Crown it became the property of the Konchay squire, and then, together with other

villages, a Serédy estate. In 1438 and 1461 Tuzsér had the right to take bridge-tolls ("tributum seu telonium") and ferry dues ("Portus naulium seu navigium"). In the 18th century it belonged to the Lónyay family. Apart from the Lónyay residence the estate has no historical or literary celebrity. In 1900 the fields attached to the village covered 1511.48 ha, of which 1061.4 ha was arable land and 102.08 ha grassland. The male inhabitants took part in the first world war; 29 of them were killed.

The only really noteworthy thing about the place is the Lónyay castle built by János Lónyay, body-guard to Queen Mária Theresa. The two biaxial wings of the castle were constructed by Miklós Ybl around 1880, when Menyhért Lónyay enlarged the castle. The allegorical frescos painted by Mihály Wurzinger have mostly perished.

Around the castle there was a well-kept park, the traces of which can no longer be seen. Nearby stood a building for the guests. The idea of renovation has been raised, but without any result so far. In what was once the garden of the castle there is a family graveyard, in which certain members of the family rest under unworthy conditions. In October 1981 it was reported that the Executive Committee of the County Council of Szabolcs-Szatmár had put preservation orders on six parks: those surrounding the castles of Anarcs, Szabolcsveresmart, Kocsord and Mándok, and the castle and mansion at Tuzsér. The Executive Committee of the County Council plans to spend nearly eight million Forints on the renovation of these parks in the 1981—1985 period.

Young prince Niki

As they say in Szabolcs county, Jenő Zoárd Odescalchi made a lucky catch when he married into the Lónyay family. There are no exact data on what he brought with him to the Tuzsér castle apart from his princedom; presumably he did not come empty-handed. His father, Artur Odescalchi was a rich landlord in North Hungary, owner of the entailed estates at Szolcsány and Szerdahely (Nyitra county) and at Illók (Szerém county). The Lónyay estate itself did not increase as a result of the marriage.

Miklós was born at Tuzsér on 6th May 1902.⁵ According to the birth register the boy's religion was Roman Catholic; Árpád Béressy, secretary of the estate, declared to Zsigmond Herr, deputy registrar on 7th May that "he gave notice of the birth on behalf of the legal father, who was unable to attend, and that he had concrete knowledge of the birth". On 11th June the same persons ascertained that the registered child had been given the following Christian names: Miklós Balthazár Livius Incze Augustus Menyhért Mária. Thus, the baptism must have been held at about that time. This all took place in the registry office at Bezéd (now Tiszabездé), because the district notary's office was there at the time. Mention should also be made of the following child, Margit, born on 8th December 1903 and given the following Christian names in baptism: Margit Johanna Erzsébet Pálma Eleonóra Emília Mária Immaculata. No further children are known to have been born. Of the parents the father was Roman Catholic and the mother Lutheran.

The Odescalchi children were given an excellent education in every respect, in accordance with their rank. This was ensured not only by the parents but also by the grandmother, who lived with them. They were educated by governesses and private tutors who prepared them from their earliest childhood to "fulfil a vocation"; they had to learn the written and unwritten rules of aristocratic life. Events later showed to what extent this purpose was achieved. Miklós was privately coached for his school examinations, and passed his final school examinations at Nyíregyháza in 1920. Contemporaries' recollections show Miklós to have been a friendly person; they often went to visit relatives at Mándok and Lónya, where they met others besides the members of the aristocracy who were present. The neighbouring castles formed an island in the world of Szabolcs and Bereg.

Miklós probably had three tutors. The first was Gyula Ditrich; the second a man with a Romanian name; the third a former Catholic priest who did not complete his training and left the order while he was at Tuzsér; after Miklós completed his schooling he became the Prince's secretary. He was generally called Your Reverence.⁶ (There is no written record of the names.) The tutor's name was László Egyedi, while the physical instructor was called Jeromos Bay.⁷

⁵ See copy of the birth certificate; in the authors' possession.

⁶ According to the recollections of a childhood friend who wrote to the authors.

⁷ From a photo copy of a typed copy of a diary written by Mrs. György Ambrózy (Pálma Lónyay); in the authors' possession. Henceforth abbreviated PL diary.



Fig. 4. Margit Odescalchi (1929–1944), daughter from his second marriage, during the war

On the Tuzsér estate Miklós learned to ride, a talent he made good use of later. In society he was Bohemian and gallant, and an excellent dancer. The gentlemen in the Nyírség and in Szatmár county (not only the gentry but the higher aristocrats, too) gave great importance to the ability to dance the czardas spiritedly. There was plenty of opportunity to do so in the Tuzsér castle and in the country mansions.

Zoárd Odescalchi was a model for his son owing to his courage, toughness and tolerance to physical pain. He trained his son in endurance and courage from his early childhood. The young prince's ideal was Ferenc Rákóczi II, seeing that the Great Prince was idolized in the family, particularly in the Forgách and Lónyay branches of the family. Margit Forgách, the grandmother, was directly descended from Count Simon Forgách, the Kuruc general, who was a faithful follower of Rákóczi.

As yet no further data are available on the young prince's youth. He was called Prince Niki and remained "Niki" even when he was grown-up.⁸

In 1917 Miklós was deeply shaken by the fact that his father, who was called up for war service as a captain in the Tenth Hussars, committed suicide at Demecser on 3rd April 1917, though this was not entered in the death register until 29th November. A note attached to the register states: "death of the captain killed during a military expedition recorded on the basis of data presented by the Home Office (79627/1917. BM. sz.)"⁹ The truth is that Zoárd Odescalchi was the commanding officer of the industrial establishments in Szabolcs county. The suicide took place under suspicious circumstances. The prince was involved in establishing war factories in the county on behalf of the Ministry of War. These included a potato processing plant, a vegetable drier, and a pig farrowing and fattening farm at Nagyhalász and a cabbage pickling unit at Demecser. At the beginning of April a committee supervised the Demecser establishment. It was then that Zoárd Odescalchi shot himself in the head. At the same time one of the managers of the factory also committed suicide, and several of

⁸ PL diary.

⁹ See copy of the death certificate; in the authors' possession.

the military staff were arrested. Even today the people of Szabolcs believe that they might have abused war funds. The records of the investigations are not available, and without a knowledge of the facts it is impossible to form an opinion. However, one piece of information seems to indicate that the suicide had no financial background. The following is a word for word quotation from Zoárd Odescalchi's suicide note: "My beloved ones, forgive me! My honour is defamed, I can stand it no longer, Zoárd." According to other sources the prince was driven to his death by reactionary forces, but there is no detailed explanation of this.¹⁰

His son Miklós was then 15 years old. He must have been well aware of the tragedy and its implications for the family; such an accident could not be discussed openly neither in the family nor in society. Everybody drew the necessary conclusions.

The war raged and the fatherless Miklós continued his studies at home with the assistance of tutors, taking his examinations, including the final one, at Nyíregyháza. For the aristocracy it was obligatory to speak foreign languages. Miklós spoke French, German, English and Czech fluently. It was his father's wish that his son should acquire a knowledge of a Slavic language too, which is why he learned Czech from his valet, whose name was Vince.

He was fond of sports, and liked to read the literature of all the languages he knew. In his youth much was spoken of Ady, although poetry was rather foreign to the circles in which he moved. Unfortunately nothing remains of the family library, which was presumably valuable, particularly as Artur Odescalchi, his uncle, was a literate man, and a considerable amount of material may have been taken to Tuzsér from his library.

War, revolutions

From the summer of 1914 times became hard for everybody. Zoárd Odescalchi was sent to the Serbian front, then returned to the county only to die.¹¹ From the estate and the village the men were called up for military service. Serious problems arose in the management of the farm; there was a labour shortage everywhere. In the village the women ploughed, sowed, harvested and delivered the crop to make up for the missing male labour as much as possible. On the estate a few skilled men were retained through exemption from military service. Then, before long, Russian prisoners of war were sent there to work as farm hands and servants. The Odescalchi family had two Russian valets, one of whom was a ploughman, the other a confectioner at home. A Cossack became the stableman and a monk the gardener. There were some clever craftsmen, an excellent tailor and a carpenter on the estate. The latter, Alexi (sic!), remained there after the war and married the Odescalchis' cook.¹²

At the beginning of the war Mrs. Odescalchi, Pálma Lónyay, hurriedly took an examination at Sátoraljaújhely, in Prof. Chudovsky's hospital, to become a nurse and then converted an outhouse into a 12-bed hospital. The patients were sent there by the Reservespital in Ungvár and were tended with the help of a professional nurse under the supervision of a physician named Dr. Sziklássy. Although there were only 12 beds in the emergency hospital sometimes as many as 32 wounded arrived, especially during the fighting in Bukovina.

In the autumn of 1914, when Galicia was temporarily evacuated, a mass of refugees swarmed on to the castle and its neighbourhood. Two hundred of them stayed in the village for two weeks. Board and lodging were provided for them by the village and the estate. They included Moldavians of Hungarian origin who were fleeing from the Romanians.

In the winter of 1915 Germans were billeted on the Odescalchi estate; a detachment of cavalry stayed there for 2 weeks. There was an officer among them, by the name of Count Saurma, who won the family's sympathies; he kept saying over and over again: "Ich sehe schwarz!" (I see black!) They laughed at him at the time, but he was proved right by the course of the war. He was later killed. With this same unit Count Kospoth and his 16-year-old son, who joined their regiment together, arrived at the castle. Prince Niki immediately made close friends with young Kospoth. They arranged a rabbit hunt in the orchard; Niki shot at the rabbit, but a small-shot rebounded and buried itself in the count's eye... He was taken to hospital with a bleeding eye. (He did not want to go, saying that "... he wanted to show his men how a wounded German officer behaved...") He was then taken to Budapest for an operation. On the way they went into the restaurant at Miskolc railway station. The

¹⁰ Information contained in a kind letter from Mrs. Dezső Török, inhabitant of Tuzsér, dated 29th September 1981. She obtained the information from a member of the family living abroad.

¹¹ PL diary.

¹² PL diary.



Fig. 5. Photo of Pál Gábor Odescalchi (Palkó), the only surviving child (1932—) in about 1936

people who saw him thought he had come from the front and greeted him with great cheering...¹³

Princess Odescalchi was quite popular in the village. People went to her on numerous occasions to get information about missing relatives or to ask her to put wounded members of their family in the hospital. She was in active correspondence with the Red Cross and with various information bureaus. They called her the mother of the vaillage.

The revolution in November 1918 brought a change. Military trains arrived one after the other, not as they left four years earlier, but bringing a disbanded army. It sometimes happened that soldiers shot at grazing cows from the windows of the train. On one occasion an exhausted, extremely drunken unit arrived home in the village. At home they went on drinking, and started shooting, at first only in the air. On the third day they began looting the Jew's shop. (Mrs. Odescalchi: "That's bad, after the Jew comes the squire!") They tried to ask for gendarmes from the chief constable of Mándok by telephone — without success. Niki was sent to Mándok on horseback, but he fared no better. By this time the situation had become critical; soldiers surrounded the castle and began looting. Not for long, however, because a troop charged with keeping order arrived and scattered the soldiers, killing two of them in the process. The relief force turned out to have been ordered off a military train about to leave for Munkács. The village and the castle were thus saved from a serious incident. It should be noted that the armed national guard did not really fulfil its task in the county; it was of little practical use.

There are no further data on the period of the bourgeois revolution. When the Hungarian Soviet Republic was proclaimed on 21st March the family were staying in their flat in Queen Vilma Street, Budapest, and remained there for another week before returning to Tuzsér.

The estate was no longer theirs, as they had already learned in Budapest. The farm was managed by production commissaries, who had the disposal of everything. One of them was to move into the castle with his family, but finally nothing came of this. The returning family found the barns, larders and cellars emptied, and had to buy back their own potatoes

¹³ PL diary.

to have something to cook. (Grosz, the village shopkeeper, offered to sell them groceries on credit, and Roth, the butcher at Mándok, wanted to loan money to them, but they did not accept either of these offers.) The farm labourers wanted to supply them with milk, but the old countess told them that they did not want to receive presents from their own men. Gábor Lónyay sent the family some food from Lónya secretly at night.¹⁴

They gave all the servants notice, for they would have been unable to pay them. With the exception of the farm co-operative the soviet regime hardly functioned at Tuzsér. The County Directory instructed the Odescalchis to send 30,000 crowns at once. Considering that private property had been abolished and the bank deposits had been seized, the Odescalchi family sent a cheque for 30,000 crowns. Most of those concerned did the same and they came to no harm...¹⁵ The soviet regime did not last long in the county, although in other places heavy fighting took place.

During the bourgeois revolution attempts were made — in a statutory manner — to solve the land problem. Leaflets distributed by the communists, proclaiming that the land would be taken away from the landlords without compensation, reached the peasants by December 1918. A land decree was passed in February 1919, according to which, only landed properties of above 290 ha would have been expropriated, and 290 ha would have been ensured for each member of the family who had agricultural qualifications. The distribution of land did not come to anything at that time. However, to soothe the revolutionary feelings, at the end of March they began to divide the 1740 ha estate of count János Lónyay, a relative of the Odescalchis, and his associates at Ibrány.

At the end of 1918 and the beginning of 1919 they began to expropriate the property of the landlords, though at the time this consisted mostly of carrying off the food and agricultural produce stored in the seigniorial granaries. This is understandable when one considers the public supply conditions during and after the war. The people's soviets were neither able nor, in most cases, willing to take the lead in movements aimed at an equitable distribution of property. The situation did not change until after 21st March 1919.

It is known that in order to ensure the continuity of agricultural production the county directory generally followed the instructions of the central organs on questions of land policy. This was a mistake, however, as it urged the formation of co-operatives rather than the distribution of land among the peasants. On 27th March the employees and servants of the Tuzsér estate held a meeting to ask for permission to use part of the Forgách estate on a co-operative basis. It was their wish that the old employees of the estate should become the leaders of the co-operative. It is worth noting that at Tuzsér co-operative farming would only have been extended over part of the former seigniorial land. This solution was attempted in other places in the county as well. At Gáva and Kiszárda the church lands were expropriated for the landless. At Záhony an attempt was made to organize a farm co-operative.

The following are the minutes of the meeting at which the servants of the Tuzsér estate wished to take part of the Salamon-Forgách estate into co-operative possession:

Minutes

made at Tuzsér on 27th March 1919 on the subject of taking over part of the Tuzsér estate, the property of Countess Margit Forgách, on a co-operative basis.

The employees and servants of the Tuzsér estate, with the enthusiastic applause of the socialist party, greet the liberators of the oppressed people and join with all their hearts in the liberal ideas of the socialist party. The dreams they thought unrealizable — the liberation of the working class, the proletariat — are finally coming true. No longer feeling the shackles on their hands, they have decided with one accord not to work the land of the estate for the selfish interests of individuals, but to direct all their effort to the welfare of the community and the country.

Being aware of the extraordinary nature of these times and knowing the enormous importance of increased production they unanimously declare that they wish to manage the Tuzsér estate on a co-operative basis under the guidance of the present leaders and to make its land fertile through their zealous work for the public good.

At the same time they ask Dezső Palánkay, Imre Körösi, József Varga and József Horváth, men of trust appointed by them, to make their wish known to the management for land affairs.

¹⁴ PL diary.

¹⁵ Ibid.



Fig. 6. Virginia Titgens, Miklós Odescalchi's second wife with one of her children (unidentifiable)

The employees of the estate have decided to ask for permission to take into co-operative possession some 653.7 ha arable land and 179.8 ha orchards and vineyards remaining from the 1207.8 ha estate situated on the area of Tiszabездé and Tuzsér after the distribution of about 118.3 ha at Bezdéd and 261 ha at Tuzsér by previous agreement with the landless people of the two villages, together with the agricultural distillery to be found on the estate.

If the management for land affairs approves the decision of the estate employees, those present ask the management to kindly support their request before the proper authorities for inventoring and taking over the estate and its equipment, which will pass into state ownership.

Before closing the minutes those present wish to record the fact that this request is made by some 104 employees and their 360 dependants living from the estate.

Dezső Palánkay, Imre Kőrösi, József Varga and József Horváth are requested to authenticate the minutes of the meeting.

The minutes are herewith closed and signed by those appointed to authenticate it."¹⁶

The soviet regime lasted forty days at Tuzsér, followed by long months of Romanian military dictatorship.

The first Romanian troops which marched in were the "Queen's Regiment". They did not stay long. Those who came afterwards were worse. The incessant requisitions emptied every farm, stable and barn. Now and then they did give a receipt for what they took away . . .

The officers were, of course, entertained in style in the castle. A Romanian officer "functioning" at Kisvárdá once visited the castle. The atmosphere was cordial. The old countess said that she spoke some Romanian. The guest, pleasantly surprised, asked her what she knew. The countess answered in cold blood: "Dute la dracu" (Go to the devil).¹⁷

This will give some idea of what the Romanian occupation was like. As one of their neighbours said: "They have taken 20 of my oxen, but they spared my life . . .!"

They knew little about what was happening in the world, since they could not travel. They subscribed to the English Daily Mail and received copies once in a while, from which they learned something about the events, and from what the Romanians let slip. At the time of the proletarian dictatorship they planned to escape to Vienna, but were unable to

¹⁶ County Archives of Szabolcs-Szatmár. Szab. dir. ir. 1919/62. alapsz. — Also published in a compilation entitled "A Magyar Tanácsköztársaság Szabolcs-Szatmárban" (The Hungarian Soviet Republic in Szabolcs-Szatmár). Nyíregyháza, 1969.

¹⁷ PL diary.

carry out this plan. Gábor Lónyay went to stay at Tuzsér; he was fed up with the Romanians' incessant molestation. (His herd of cattle was carried off, and so was half of his American stud; the other half he succeeded in taking to Tuzsér.) They were repeatedly summoned to appear at the Romanian headquarters in Kisvárd, but no particular harm was done to them.

In February 1920, after ten months of foreign regime, the proprietors of the estate reoccupied their old place. And this takes us to the land, the estate, the essential element in the life of an aristocratic family.

The estate

To begin with, a generally known and accepted legend should be dispelled: the famous Tuzsér estate did not belong to Miklós Odescalchi; his father did not bring any land into the marriage. The land was originally the Lónyays' property, and Countess Pálma Lónyay remained the owner even after her marriage to Zoárd Odescalchi. There was another estate there, that of Countess Forgách, part of which Miklós inherited, mostly at Torniospálca, after the death of the old countess (1938).

The statistical data for 1895 give the farm area of Szabolcs county as 534,084 ha, since, when the distribution of the farms according to character and size was examined, properties consisting only of grassland and forest were left out of consideration. Apart from the latter, farms larger than 58 ha covered a total of 319,249 ha, i.e. 72.8% of the land.

Only approximate data are available on the size of the "Odescalchi estate". The property at Tuzsér was probably around 870—1160 ha. At Rétköz, also in Szabolcs county, there was another landed property of about 2320 ha. The proprietorship was very confused. The use of the Forgách land at Mándok was the right of László Forgách's widow; Margit Forgách (Mrs. Salamon), who lived at Tuzsér, had a landed property of considerable size; Zoárd Odescalchi's wife, later wife to György Ambrózy, also possessed land, and there were also the two children, Miklós and Margit.

After 1945, during the land reform, a 419 ha area with a value of 7045.93 gold crowns was expropriated from Miklós Odescalchi at Tuzsér and 148 ha, valued at 77 gold crowns, at Torniospálca, while 25.5 ha was expropriated from Margit Odescalchi, wife of József Lanczia, at Záhony.¹⁸

These data are misleading because they do not give even an approximate idea of the original size of the estate. According to many witnesses the estate totalled about 5800 ha, of which Miklós Odescalchi owned 1740 ha. He also received a monthly allowance of 3000 Pengő from his mother. It is known that when Pálma Lónyay, the widow of Zoárd Odescalchi, married a second time, her new husband, György Ambrózy, succeeded in "relieving" Miklós and Margit, the Odescalchi heirs, of some 580 ha forest and 290 ha arable land occupying a large part of Rétköz, the property of Gábor Lónyay, who died on 23rd November 1927. The same also happened to a large part of the Tuzsér estate. This caused domestic strife, and relations between the step-son and the new step-father became strained and formal; it was only for his mother's sake that Odescalchi overlooked for a while the squandering of the land.¹⁹

Thus, Miklós Odescalchi's landed property was not particularly large, in contrast to the legends told about him. The estate was under joint family management, and he, personally, probably had little to do with farming, though he was a specialist in spending the income.

Nevertheless, it is worth looking more closely into the question, as the famous apple plantation, which later became known all over the world primarily through the tasty Jonathan apples, is associated with the name of the Tuzsér estate.

The first written records of fruit cultivation in Szabolcs and Szatmár are of mediaeval origin. The alluvial areas beside the rivers are ancient fruit-growing areas, which have not only good soil and climatic conditions, but also favourable transport possibilities that make them very suitable for apple production. The old centre of fruit growing in the county was the valley of the River Tisza, from Vásárosnamény to Záhony, and still farther to Szabolcs-Veresmart in the direction of Dombrád. So-called jungle-orchards of a similar nature were found along the valley of the River Szamos in Szatmár county.

The oldest cultivated orchard and fruit-tree nursery in the Nyírség was found at Tiszavasvári. From the original orchard areas the apple was the latest to reach the inner parts of

¹⁸ Information given in a letter from Mrs. József Ujlaky, director of the Kisvárd library, on 26th September 1981.

¹⁹ Information in a letter written by János Szabó, inhabitant of Nyíregyháza, on 31st August 1981.



Fig. 7. Obituary published by the family in 1945. It contains some errors, including the data of his death, having been formulated after contemporary news. His wife had probably not yet returned from Transdanubia, so her name was not included in the text

the Nyírség. On the area of the present Szabolcs-Szatmár County there were 168,293 apple-trees in 1895; this number rose to 634,807 by 1935.

It is known that in the second half of the 18th century, in the period of enlightened absolutism, the large number of new inventions and the quickening colonial trade promoted the development of industry and trade. Many foreign plants were introduced into Europe, and also into Hungary, due to the interest shown by the aristocrats and Church dignitaries in everything new and exotic. In France and Belgium new fruit varieties were produced en masse. Pomological associations were established. Fruit production, horticulture and flower growing served to satisfy the increasing demands, and at the same time ensured a good income for those engaged in them. The varieties obtained from abroad resulted in the creation of pomological collections in Pozsony, Eszterháza, Sopron, Körmend and Tuzsér. Besides the pomological associations, agricultural societies were also active. The horticultural societies were also active. The horticultural societies established nurseries and stock orchards and systematic fruit-tree propagation was begun. New apple varieties were introduced (Londoni pepin, Batul, Jonathan, Kanadai renet, Téli arany parmen, etc.). The first nation-wide apple-tree census was completed in 1895.

The Tuzsér orchard was planted by members of the Lónyay family before the birth of Pálma Lónyay. It was on the banks of the River Tisza. Later, at the turn of the century and in the 1910s Zoárd Odescalchi established an apple orchard beside the railway station at Tuzsér. After he died, in Ambrózy's time, a large number of apple trees were planted, mainly at Rétköz.²⁰

The Tuzsér—Rétköz model farm formed the basis of the estate even between the two world wars. At an exhibition organized in the autumn of 1937 at Nyíregyháza the model farm displayed its apple varieties with great success. At that time 47,754 fruit-trees produced the excellent Szabolcs fruits on an area of 638 ha. The apple-trees were thirty-two thousand in number, of which 12,400 were Jonathans. But there were also Batul, Tafotta, Muskotály, Damezoni renet, Ádám parmen, Langsberg renet, Londoni pepin, etc. trees. The model farm produced 90 waggons of apples a year. The apples were placed in rented cold-storage in Budapest and from there were transported abroad.²¹

²⁰ See footnote 6.

²¹ The beautiful apples grown by Countess Pálma Lónyay, wife of György Sédeni Ambrózy, in the fruit pavilion. Nyírvidek-Szabolcsi Hírlap, 12th September 1937, p. 7.

The subject of apple production has been dealt with in some detail. The generally accepted name for this gold-mine of apple production was the Ambrózy Model Orchard and Farm, the owner of which was Countess Pálma Lónyay, wife of György Sédén Ambrózy. The old orchard (75 ha) was established by Mrs. Margit Salamon née Forgách, the grandmother; a further 52.2 ha was planted by Zoárd Odescalchi in 1912, and another 116 ha by György Ambrózy. The size of the farm was 778 ha immediately before World War II.

The main produce was naturally apples. The sorting and ripening unit was the only one in the country. Production was carried out with up-to-date equipment under expert management. Sixty-eight families were permanently employed in the farm and 30 in the orchard, while seasonal workers were hired for 40 thousand work-days. The general manager of the farm was Márton Palesó, a graduate of the Agricultural Academy, Debrecen, who took up employment at Tuzsér in 1909; in 1939 he was appointed agricultural adviser. Mihály Héry, manager of the orchard, began his career in the Rétköz farm as a trainee in 1927, then became bailiff's assistant in the Tuzsér farm and from 1934 manager of the Tuzsér model farm. Ferenc Ináncsi Papp worked with him as a trainee. Ferenc Schamschull was first employed on the Odescalchi estate in 1912, and later became chief gardener supervising 174 ha of fruit-trees.

The general manager of the Rétköz estate was of Jewish origin, as was the lawyer, Dr. Lipót Vadász, who became editor of the "Kisvárdai Lapok" in the eighties of the last century; besides his prosperous solicitorship he was a member of Parliament for the Nyírbátor district and State Secretary of Justice when Count István Tisza was Prime Minister. It is interesting to know that Béla Somogyi, the murdered "Népszava" journalist, began his career on the newspapers with the "Kisvárdai Lapok"; while acting as tutor to the children of a leaseholder of one of the Forgách Counts he made the acquaintance of Vadász.²² After Dr. Lipót Vadász, Dr. Miklós Schönwald acted as lawyer to the Odescalchi family, followed by Dr. János Rubóczki after they had taken over Tornyospálca.²³ Besides Tuzsér the family naturally had other landed properties.

The hemp processing factory built on the Rétköz farm of the Odescalchi estate, in the fields near the village Nagyhalász, was a seasonal plant in which production started in April 1906. Machines and skilled workers were brought from Germany. During the work season 80–100 workers were employed for 12-hour working days at low wages. Retting was carried out near the factory by 25–50 workers. The factory produced stripped raw hemp mainly for the German market. For the domestic market, manual hackling and ropelaying were also carried out. In the ropelaying unit 70–80 men were employed.

During the first world war a new enterprise was launched by the owner. He had a big red-brick building erected by Russian prisoners of war to serve as a distillery. The raw material consisted of potatoes and fruit grown in the neighbourhood. Due to its red brick walls the distillery was called the "red factory" by the inhabitants of Nagyhalász. With the death of Zoárd Odescalchi distillation was discontinued and the building was used for storage. The new owner was more concerned with modernizing the hemp factory. In 1935 it was furnished with a dust extractor. Then things took a turn for the worse: the machines became outworn, and production costs were high. In 1941, to avoid going bankrupt, Ambrózy offered the plant for sale to the Szeged Hemp Processing Company. The transaction was soon effected and the factory changed hands again. During the second world war a short upswing could be observed. The then manager of the factory had a light railway constructed to the factory and had the retting pit repaired. Fibre for spinning was pressed in bales of 100 kg, transported to Kemece by horse-drawn railway waggons, and from there, again by train, to the Szeged spinning factory for further processing.²⁴

On the Nagyhalász estate the bailiff was László Nagy, who was followed in office by Géza Bakó; the manager was named Soltész. Here Miklós Odescalchi had a farm at his own disposal.²⁵ The farms called Kettőkőz and Nagysziget were also family properties. Further farms belonging to the family were situated at Ibrány (Nagyerdő, Tuskolán, Jalapár).

Part of the landed property at Tornyosháza was mostly covered by acacia forests, one of the most profitable plants grown on the sandy Szaboles soil, since it can be felled every twenty years. On the basis of Act XIX, 1898, birch and oak trees were replaced by acacia

²² Károly Nyéki: Somogyi Béla és Kisvárdai (Béla Somogyi and Kisvárdai). — Kelet-Magyarország, 10th December 1980, p. 2.

²³ See foot-note 6.

²⁴ R.G. (Reszler Gábor): To be erected on Sziget farm. The hemp processing factory at Nagyhalász was built 75 years ago. — Kelet-Magyarország, 26th July 1981, p. 8.

²⁵ Verbal information provided by Mrs. István Kovács, Füst S. u., Mátészalka.

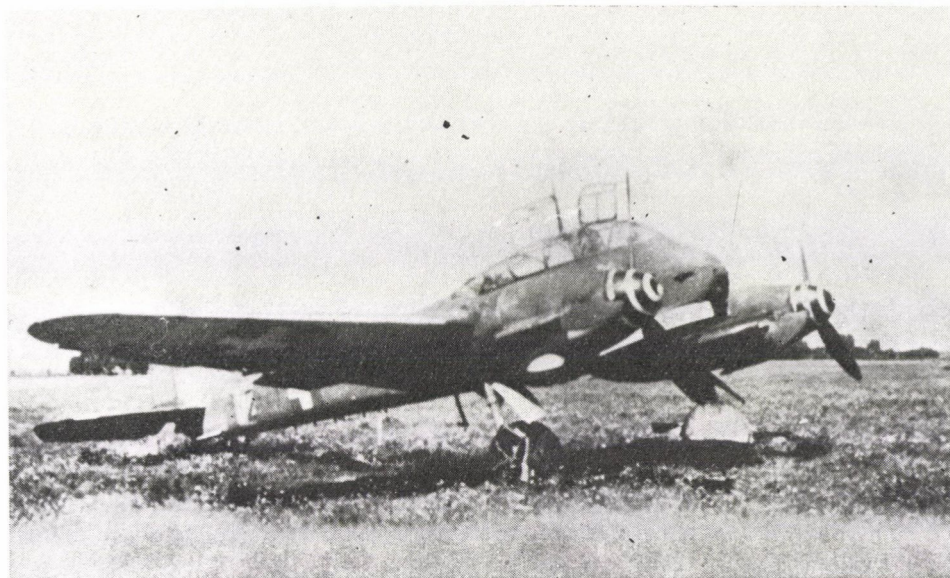


Fig. 8. A Me-210 Ca-1 fast-bomber in spring 1944 in the Hajdúböszörmény military airfield, from the No. 102/1 Sas squadron. It is of the same type as that used by Odescalchi in leaving the country. The number and sign of his plane have not been identified

to make up for the reduced forest area and to fix the sandy topsoil. Plantation was first carried out while Count László Forgách was still alive, and this area was inherited by Miklós Odescalchi. There he had a country house which is now a culturecentre. At Torniyosháza there was also a distillery.

Mándok was the centre of the Forgách estate. The Mándok farm included land at Tornyospálca, Pusztajfalu, Mezőladány, Eperjeske, Tiszabездéd, Tiszamogyorós, Tiszaszentmárton, Zsurk, Eszeny and Szürthe, which totalled 8291 ha at the beginning of the century. After the death of László Forgách III, the estate was inherited by his sister Margit, Miklós Odescalchi's grandmother.

More than one-third of the agricultural distilleries in Hungary were established in this county; they were operated from October to March or even until June. Each of the distilleries — about seventy altogether — was operated (in 1938) by an average of 5—8 workers. The raw material was in most cases potato, which greatly helped the potato producers in good crop years when, despite the excellent quality, such large quantities of potatoes could not otherwise be sold. Further, the distilleries played a very important role in animal fattening. In sandy regions poor in fodder crops the malt returns were indispensable.

The Odescalchi family had distilleries not only at Tornyospálca but at Rétköz and Tuzsér too.

In the thirties mint production was started in Szabolcs. After harvesting the mint either had to be air-dried in the sun or in artificial driers. A small peppermint distillery was operated by the Odescalchis at Rétköz.

The estate was managed well, in accordance with the capitalist requirements of those days. Tuzsér had a railway station, so transportation did not cause any particular difficulty. As for public roads the situation was much worse. On a county scale they were in a favourable position, as shown among other things by the list of tax-papers: in 1912 Zoárd Odescalchi was the seventh in the county (preceded by Counts Miklós, Aurél, Dénes and Béla Dessewffy, and by Ferenc Kornis and Herman Reizmann), while in 1916 he had dropped to ninth place in the list.

It is worth mentioning that at the end of 1938 a Bill concerning children's allowances for workers was passed (Act XXXVI/1938). According to this law, certain groups of industries formed professional family pay-offices, to which the employers and the government con-

tributed payments based on a certain scale, and the workers received a monthly family allowance of 5 Pengős for each child under 16. The sawmill on the Ambrózy estate at Záhony and the Odescalchi's hemp processing factory at Rétköz were included in the county records of plants employing more than 20 workers.

Prince Miklós Odescalchi

Young Miklós was gradually growing up. During the Great War he decided to join the army with his friend László Vadnay, son of the station-master, who was two years his senior. He ran away from home three times, but naturally always failed to be accepted by the army.²⁶

This cooled his enthusiasm. A few years later, however, he set off to "fight" the Reds with another friend of his. On the way they fortunately called on a relative at Lónya, Count Gábor Lónyay and told him about their plan. He said that the Reds had gained a victory at Beregszász and "were hanging the Whites". The old gentleman's great prestige and the change in the situation made them give up their hazardous plan.

Nevertheless, it seems that with persistence anything can be accomplished, because a little later, after the fall of the proletarian dictatorship, Prince Niki ran away again, this time with more success, because he was admitted to the national army. However, with the help of an officer, an acquaintance of the family, he was taken home again. He appeared in the Tuzsér castle in military uniform with a feather in his cap. He had to put off saving his country while he completed his studies.²⁷

No events worth recording are known from the twenties. Miklós Odescalchi was a rich man, much liked in the highest aristocracy. He was gay, reliable, brave and energetic, though a little self-willed; his stubbornness was generally known. That was certainly the reason why, in his one year's service as a volunteer, he did not make a military career for himself. He joined the Fourth Hadik-Hussars at Nyíregyháza and was only a corporal when discharged in 1923. He was often teased about this by his friends.²⁸ Later he took part in army exercises on three occasions, but there are no data on his military advancement.

After his discharge from the military service he became quite successful in the field of sport. He was fond of horses from his early childhood. His relatives at Lónya and Mándok had famous stud farms. Of course, he had horses on the Tuzsér estate as well, and had a favourite riding horse; his sister had ponies and a light chestnut mare named Bairam from the Dreher stud farm. The latter was harnessed to a carriage during the Romanian occupation, and, not being used to this, bolted and nearly killed its new, unauthorized master.

Prince Niki, as a gentleman-rider, took part in gallop and hurdle races with good results even abroad. Owing to his corpulence, however, he would have had to keep to a strict diet to get down to a suitable riding weight, so he changed over to show-jumping, at which he excelled. In Budapest the first riding and jumping competition was organized on 11th May 1894 by the National Hungarian Agricultural Association and the Memorial Horse Breeding Society. Later further societies were established one after the other. Riding as a sport made progress, and competitions became regular. The Hungarian National Association of Equestrian Sport Clubs was established in 1924; it supervised the co-operation between the riding clubs and directed sporting life until 1944.

Prince Odescalchi enjoyed riding so much that in two national competitions he won first place in the show-jumping, once in 1928 and again in 1929. In the following two years Ottó Binder and Ottmár Schaurek were the champions. His performance was highly remarkable for a civilian, as with few exceptions this sport was cultivated by officers. Of course, his success was partly due to his excellent horse, Gradasso.

He had two cars, one of them a sports model. Numerous legends are told about him, emphasizing his boldness and uninhibited nature. Though not of decisive importance in a biography, some of these cases are worth mentioning. Once he seated some gipsies in his car at Nyíregyháza, took them up to Budapest, and then let them go — after giving them 100 Pengős. The gipsies were frightened to death and asked him to show them what direction they should go in to get home.²⁹ Another case was that of two rabbis walking towards Nyíregyháza whom he picked up, but who were shot out of the car when he took a bend at great speed.³⁰ This case is mostly told by those who would like to emphasize his antisemitism,

²⁶ PL diary.

²⁷ PL diary.

²⁸ Recollections of Gyula Katkó, inhabitant of Tuzsér, taped at Tuzsér on 24th April 1981.

²⁹ Verbal information provided by György Csiszár, Kisfaludy u., Mátészalka.

³⁰ Verbal information provided by László Muskovszky, Kisfaludy köz, Mátészalka.

although he was not an anti-Semite. Once he gave a lift to Pál Rozi, hatter of Kisvárdá; on arriving at Kisvárdá he shouted to the hatter's wife that he had brought her husband home. But the hatter was nowhere to be found, he had fallen out on the way. They say that the same happened to the Kisvárdá butcher.³¹

In the summer of 1930 there was a well-known incident when he hit a policeman who requested him to show his identity card. At police headquarters Odescalchi defended himself by saying that he "pushed the policeman out of the way in a polite manner to save him from being run over; the policeman probably did not see his gesture properly and misinterpreted it".³²

He often made trouble with his sports car in the village, running over poultry, though to do him justice it must be said that he always paid for the damage. Once the village people placed a board with protruding nails on the road³³ — but it had no effect. In spite of his vagaries he was liked by the villagers, because he was good-hearted and helped the poor. He was even known to give his own bed linen and clothes to a poor sick person.³⁴

His over-bold driving once caused a tragedy. Coming from the Tuzsér castle in his Lancia on 10th October 1938, on the road between Nyíregyháza and Debrecen, he ran over and killed Gábor Varga, a 45-year-old shoemaker, whom he took to the Debrecen clinic after the accident. The Prosecution charged him with manslaughter through negligence. After such preliminaries the case came up for trial at the Debrecen criminal court, where Odescalchi was defended by Dr. Zoltán Porkoláb, a lawyer from Nyíregyháza. The latter did his work rather well: although Odescalchi was found guilty he was only fined 2000 Pengős. The court did not ban him from driving, though many state the opposite even today.³⁵

His family life was very spectacular. As mentioned before, his father committed suicide on 3rd April 1917. Later his mother married György Ambrózy, a cavalry colonel, Knight of the Order of Maria Theresa. (The Order of Maria Theresa was the highest Austrian military order given exclusively to officers who, without orders from their commanders, carried out a military action which decisively influenced — or at least greatly promoted — the outcome of a battle. The holders of the order were raised to the rank of Austrian baron.)

Miklós married, too. His first wife was Baroness Irma Lüttvitz, who divorced her first husband, Baron Gustav Braun von Stumm, counsellor at the German legation in Budapest. The marriage began romantically, and Miklós even fought a duel with the ex-husband; the baroness was a famous beauty but had no fortune. In addition she was nine years older than Miklós, who was then only 20 years old. The marriage, which was contracted in 1922, did not last long; they were soon divorced.

His second wife's name was Virginia Titgens. Also a divorcee, she came from America, where her father was said to be a rich manufacturer. She had a daughter nicknamed Peci, whom she brought with her; later the child returned to the United States. From this marriage two children were born: Margit (25th April 1929) and Pál Gábor (19th February 1932, in Budapest). His second wife, who was known as Princess Gini, died in spring 1944 after a long illness and was buried at Tuzsér. Their daughter Margit, who was nicknamed Baby, was a highly sensitive, beautiful little girl, with "democratic feelings" according to those who remember her. On the evening of 29th May 1944, at the age of fifteen, she committed suicide with poison for unknown reasons. She rests at Tuzsér in the family graveyard.³⁶

Their son Pál, called Palkó by the villagers, who was left father- and motherless at the age of 12, was taken legally to the USA by the American grandparents in 1946; he was brought up first by them, and then by his half-sister, Mrs. Willson. Pál has been living in the USA ever since and has two grown-up children.

His third wife was Erzsébet Perczel of Bonyhád, daughter of General Armand Perczel and Countess Ilona Toldalaghi. Little is known about her; at present she lives in New Zealand. Her two brothers, Miklós and József died in Buda, under unfortunate circumstances in 1945.

She was arrested by the Gestapo on 7th July (according to other data on 10th July) 1944 and was in custody in the military prison, Fő utca, Budapest, then, when the prisons were evacuated on 8th November 1944, she was transferred to Vienna. On 17th January 1945 (?) she was taken with others to Sopronkőhida, but was soon freed. Before the verdict

³¹ Verbal information provided by István Szabó, Poroszlai út, Debrecen.

³² Prince Odescalchi appeared at the Budapest police headquarters this morning, where his interrogation began. — Nyírvidek, 31st July 1930, p. 1.

³³ Recollections of József Tempfli (Zalka M. u., Mátészalka) taped on 23rd July 1981.

³⁴ Recollections of Mrs. Dezső Török, inhabitant of Tuzsér, taped on 24th April 1981.

³⁵ Fatal car accident caused by Prince Miklós Odescalchi comes before the Court. — Nyírvidek-Szabolcsi Hírlap, 2nd February 1939, p. 2.

³⁶ Recollections of Mrs. Dezső Török and Gyula Katkó, taped on 24th April 1981.

she was allowed to speak to her husband for 10 minutes in the presence of two guards. She heard of the execution in a nearby village from the prison priest.

Later in 1945 she took Pál Odescalchi to live with her; up till then he had been staying with relatives. Certain recollections indicate that the War Minister of the day promoted Miklós Odescalchi post mortem to squadron-leader in 1946, and awarded him the Kossuth Medal.³⁷

There are some contradictions here, however, since according to the decree No. HM-27.501/1. SzÜ-1945 Democratic 1945.VI.b. the War Minister promoted Reserve Lieutenant Miklós Odescalchi post mortem to reserve major and transferred him to the effective strength of the army, so that his widow — in accordance with her earlier application — could be given an officer's pension and her step-child an orphan's allowance.

"Justification: Prince Miklós Odescalchi was in contact with leftist resistance groups and flew to Italy in June 1944 with the knowledge of the Governor to arrange negotiations for an armistice and help politicians to leave the country."

The mistakes found in the original document make it obvious that it was written on the basis of verbal information. It does not contain further details. No documents confirming the award of a medal have been found so far; in 1946 he could only have received the Order of Hungarian Liberty, with Kossuth's embossed image on it. The Kossuth Order was not established until much later.

Before the fatal journey

It is said that Odescalchi was an undisciplined but brave man. He was a famous sharp-shooter; when hunting with his friends he often shot at running rabbits with a twin-barrel rifle, which was naturally unpopular with the other hunters, since they were familiar with the sound of the ricocheting bullet, but it was impossible to judge the direction . . .³⁸

Flying played an important part in both his life and his death.

He learned to fly privately at Budaörs from the well-known pilots of the day. One of them, János Majoros, who was later chief engineer with MALÉRT (the Hungarian airline of the period) was often a guest at Tuzsér. Antal Bánhidi (the famous constructor and amateur pilot) was one of his instructors, since he was the trainer of the Amateur Pilots of the Technical University; he had no respect for his rank and failed him, since the pupil was very undisciplined and often impertinent. Finally, Odescalchi succeeded in passing the examination and bought a two-seated Junkers Junior sports plane from the Junkers factory in Dessau,³⁹ the wings of which could be removed. His mother had a plank hangar erected in a field at Tuzsér. The machine, with its wings removed, was pulled into the field by a groom named Miska, where the wings were re-attached, again with the help of the groom, and then the reckless performance began.⁴⁰ He took many people for rides in his plane, and had a fine instinct for choosing those whom he could frighten with his stunts. Numerous cases connected with one or another of these stunts are known all over the country. One of his favourite amusements was to fly very low over the main street of the village; people working in the fields were also frightened by his low-altitude flying. At Tornyospálca he sometimes landed on the grazing land, to the great delight of the children.⁴¹ Once, after an argument about courage with a nearby landowner, he took him up in his plane and looped the loop. It is said that on one occasion when the river was low he flew under the Suspension Bridge in Budapest, though others say it was the Tisza Bridge at Tokaj (the latter is more likely). He performed stunts like this in Nyíregyháza as well; during his military service he once flew in formation with some of his comrades between the two towers of a church.⁴²

At the end of the thirties (possibly in 1938) an air display was organized at Nyíregyháza, and the spectators warmly applauded the thrilling show put up by the civilian Odescalchi. He also made fairly long flights with his friends, most of whom were members of the high aristocracy, as he did not willingly make friends with others.⁴³

³⁷ Information by letter from persons on friendly terms with the family, dated April 1978 and November 1981.

³⁸ Information given in a letter dated 19th May 1981 from György Németh, Budapest. (György Németh died at the end of 1981.)

³⁹ Information from János Szabó, Nyíregyháza, in a letter dated 31st August 1981.

⁴⁰ See Footnote 6.

⁴¹ Verbal information from Mrs. Károly Tinai, nursery school teacher at Mátészalka.

⁴² Recollections of József Tempfli, Zalka M. u., Mátészalka, taped on 23rd July 1981.

⁴³ Information in a letter dated 24th January 1980 from István Kozma, a resident of Kemece.

Odescalchi's Junkers Junior airplane was registered as HA-MAX. In about 1939—1940 he sold it to the TSE air club; it was used there during the war.⁴⁴

Odescalchi became a reserve air-force officer, and flew relatively often in light machines. He spent his training period in fighters, but was not trained on multi-motored aircrafts able to fly in bad weather.

In 1940 he was called up for military service in the air-force, and as a reserve officer received a regular pilot's training, probably at Nyíregyháza. It was probably then that he was raised to the rank of reserve lieutenant. The air-force did not wish to transfer him to the active strength.⁴⁵ He was undisciplined, but later, when in the air-force, he was obliged to obey orders.

During the war the Air Force Headquarters refused to send him to the front, giving his age (42 in 1944) and his lack of experience as justification. However, owing to a shortage of pilots at the beginning of 1944, he was called up again and trained at Ferihegy to pilot Me-210 fast bombers. After 19th March 1944 (the German occupation of Hungary) Odescalchi contacted several reserve air-force officers, who formerly flew with MALÉRT, then with the transportation squadron. He displayed an open anti-German attitude, particularly despising the SS, and raised the idea of flying over to the Allies, but as far as is known at present, without any definite aim or mission. This was so much of a provocation, that it was at once reported to László Háry, retired brigadier general, who in turn had long been in contact with Squadron-leader Gyula Tost, the Governor's adjutant, and through him with the men of the Desertion Bureau.

He did not inform the members of his family about his plan to desert. Only at their last meeting did he mention it, adding: "It is likely, in fact certain that my estate will be confiscated, but much greater things are at stake now!"⁴⁶ It was at about this time that he told one of his childhood friends that he intended to try and fly over to the other side.⁴⁷

In May 1944 while entertaining guests in the country he asked one of them to give him an air-map showing the Budapest—Milan flight path together with part of Italy, and never gave it back to its owner. The owner of the map made the following remarks about this occasion and the role of the map in 1979. "In around March 1944 my wife and I were invited to Odescalchi's estate in the country. If I remember correctly, his second wife was still alive, but was in a very bad nervous state. Odescalchi had then only just completed his retraining at Ferihegy for piloting an Me-210 fast-bomber, so he asked me to take a map along with me for a navigation exercise, as he would like to "fly in his imagination". Knowing that he had no experience of piloting heavy machines I took an unused MALÉRT air-map which happened to be at hand, which showed the Budapest—Milan flight path to a scale of about 1 : 100,000, with all the airways, directional angles, fixed points etc. It was thus a special map that you just fixed to your knee and followed without having to make any calculations. Everything along the Budapest—Zagreb—Trieste—Milan flight path was indicated on it, including a large part of Northern Italy, but not Rome and the region below it. It was on that map that we discussed navigation methods, and soon afterwards my wife and I left. Unfortunately I made the mistake of leaving the map there, which later nearly cost me my life."

Odescalchi made a great mistake in not destroying the map at once if he could not use it. It was definitely a clue, and dangerous, too, as he could have had no legal access to it. If the Hajdúböszörmény—Pécs line is extended it leads approximately to Ancona, which is a distance of about 900—950 km. This was too far to the north, as the front was farther southwards, and anyway one could not fly directly across the Balkans or Croatia. Cities and anti-aircraft defence zones had to be avoided, while characteristic points had to be used for navigation. Whether or not Odescalchi knew the exact position of the front has never been discovered. He may have known, since it was generally known in air-force circles, that after April 1944 the American bombers launched their attacks from Italian airfields in the neighborhood of Foggia.

The protrusion of the Italian peninsula at Foggia shows a very characteristic formation, easy to identify even from a high altitude. This region is at a flying distance of 1100 km from Hajdúböszörmény, and even with detours it is only 1200—1400 km.

⁴⁴ Csanádi—Nagyvárad—Winkler: "Magyar Repülés Története" (History of flying in Hungary). 2nd ed. Budapest, 1977. 350 p.

⁴⁵ Verbal information from Captain Kálmán Háry, then commander of the 102/1 fast-bomber squadron, given in 1978.

⁴⁶ According to information obtained by Mrs. Dezső Török from relatives living abroad.

⁴⁷ See foot-note 6.

Since the plane had a cruising speed of 410—480 km/hr, a range of at least 1600 km and a flying time of 3 hours, it could be used to reach any point between Ancona and Bari.

It is obvious that he could not have used a regular flight path without this being registered. The map in question could only have been used over Croatia, but even this would have been of little use if the directional angle, time and points of turning were not calculated for the whole flight path in advance. After taking off there is no chance of doing this. Since he set off on a routine training flight he must have started after the order of the day had been read and breakfast finished, at about 9 a.m., so he may have landed before lunch. This is realistic and ties up with other known data. The place at which he landed has not been identified.

Nothing has been heard of Lance-sergeant Ferenc Bajusz since 1945, though he may still be alive. None of those investigating the circumstances of the fatal flight have succeeded in contacting him.

Research should be continued on Italian territory, among the local documents or American data concerning the area, but the authors have had no opportunity to do so.

It should be noted here that even the exact data of the flight is uncertain, because sources mentioning 3rd or 4th June and 13th June 1944 are equally reliable. Up to now there are no documents which definitely fix the date of the event.

In May Odescalchi was called up to the newly-formed fast-bomber squadron 102/1 sz./Sas/M. kir. Légierő at Nyíregyháza, set up at the Hajdúböszörmény military airfield under the commandship of Captain István Herszényi. In the morning of 3rd or 4th June 1944 he was in Budapest and told the owner of the map that a few days previously he had made an attempt to fly to Italy, but after flying over Pécs he got into clouds and turned back, so the training flight seemed undisturbed. He could not be talked out of renewing his plan later.

That evening they attempted to remove him from the air force for safety reasons, as his attempt seemed to jeopardize Count István Bethlen's plan to fly over to the Allies. Brigadier-General László Háry could not get in touch with anyone competent that evening, but promised that first thing next morning he would have Odescalchi discharged and transferred telegraphically to some ground post through the Governor's Military Bureau. In the evening Odescalchi flew back to Nyíregyháza and gave a dinner-party, which was attended by Lieutenant-Colonel Mihály Nagy, airfield commander, Captain István Herszényi squadron commander, his women acquaintance Countess Erzsébet Alberti Denao,⁴⁸ and many others.

Next morning Odescalchi took off, seemingly for a training flight. Lance-Sergeant Ferenc Bajusz was the signaller-rifleman in the two-seater Me-210 Ca-1 fast bomber, and he only learned where they were heading after they had taken off. There was no room for anyone else in the plane, so they could not have taken any passengers, if only for technical reasons. The tanks were full, so the plane could cover a distance of some 1600 km. Since it did not return on time a search warrant was issued; to start with it was assumed that an accident had taken place.

On 5th June counter-intelligence (VKF-2) agents arrested all those who had attended the dinner at Nyíregyháza. They then searched through the living quarters and found the air-map Odescalchi's table. On the basis of its number they arrested its owner next day. Attila Berényi, László Vadas, Endre Melita, Pál Zichy and others were also arrested. (It is interesting that there are no data on the arrest of Captain Takács, the officer then on duty at the airfield.) Odescalchi's sister was captured by the anti-intelligence men on 14th June in Jobbágyi and was taken to Debrecen, where she was in custody for two weeks. Her son was hidden in Salgótarján as a deserter.⁴⁹

Those arrested were transferred to Budapest, and the investigation was begun in the Gestapo centre on Sváb Hill under the guidance of German Chief Inspector Kote. In a few days it was discovered that the Me-210 plane had reached the Italian coast farther to the north than planned, possibly because of some error in navigation; there was also a contrary wind, which required increased fuel consumption; it flew over the German lines, then landed in an airfield used by fighter planes. The crew said that, while pursuing American bombers, they had got into thick clouds over the Balkans and lost their way. The Germans accepted this and invited them to dinner. The meteorologist of the aircraft unit, who was also present,

⁴⁸ Countess Erzsébet Alberti Denao was in contact with Odescalchi in 1942—44. She was arrested in Debrecen by the Germans, sent to a concentration camp, and then released in spring 1945. She was last seen in Vienna and has probably been living in the West ever since; her role has remained unclear.

⁴⁹ Éva Földes: "Even in the country of the atom-bomb I serve the cause of human progress and peace" — Asszonyok, 1st November 1948. p. 9.

did not understand how there could be a rain front over the Balkans that he did not know about. He telegraphed inquiries to Luftflotte-4 headquarters. The answer was a circular telegram with the superscription "Streng Geheim" about the desertion; the rest was up to the SD men. In the evening both aviators were arrested and transferred to Vienna. They were kept in custody by the Gestapo for a long time and were not extradited to the Hungarian authorities until the middle of December.⁵⁰ The Germans knew about the attempt to establish relations in the interest of an armistice, which is why they kept the captives in their own custody, counting on possible further actions; however, after 14th October 1944 the subject was no longer of interest.

After a month or so two of those arrested, Mihály Nagy and István Herszényi, were set free but immediately removed from their posts; it was then that Captain Kálmán Háy became commander of the 102/1 squadron. A few days later the other pilots were also freed, but the owner of the map was not released until November 1944. The Me-210 machines were then withdrawn from Nyíregyháza — though for other reasons — and put into action in the Carpathians.

It is said that Horthy, the Governor, who still maintained relations with the Germans, interceded for him after his arrest, but a severe punishment was demanded. No other attempts to save him are known of at present, and even that mentioned is uncertain.

One may well ask: what was his aim or task when leaving the country, and why did he want to go to Southern Italy of all places? Who commissioned him to do so, or was it yet another of those actions which demonstrated Odescalchi's headstrong nature? These are all questions which have been left unanswered.

There are no reliable data to indicate whether he acted on behalf of the Desertion Bureau. For the time being we do not even know whether he took any message or document with him.

According to the charge brought against him he may have had the task of making preparations or arrangements for a situation when "leading politicians" would also have left the country by flying across areas of military operations. The charge also suggests that Odescalchi knew a "secret" and was to reveal it to the "enemy". This might have been a definite secret or just something of a general character. Since the record of the case has not been found so far, it is impossible to take up a definite position on the question.

Immediately after the war various versions of the attempt to fly over to the allies were in circulation. According to one of these Odescalchi wanted to help one or more persons to get through the front to Southern Italy to enter into peace negotiations, but German fighters forced him to land and arrested him. In another version it was by mistake that he landed on an area still occupied by the Germans and not by the Allies, and that is how he fell into the Nazis' hands.⁵¹ Some said that Italian partisans tried to help him in a gunfight, but the Germans won by force of numbers. The version described above in detail seems to be the most authentic.

Why was it Italy of all places that he wanted to go to?

It is a well-known fact that by then the British 8th Army had gained considerable areas in Italy. The Odescalchi family also had Italian relations, though we have no exact knowledge of the quality of those relations from a political point of view. Between the two wars Miklós Odescalchi paid repeated visits to Italy; the Italian branch of the family was still flourishing then. It is perhaps of interest that the Odescalchis of Rome still own the family's palace in Rome, and also Bracciano, the ancient castle in the neighbourhood of Rome, a place much frequented by tourists. Gromyko, the Soviet foreign minister, stayed at Bracciano as Prince Odescalchi's guest when visiting Rome, both because they were acquainted and because it was easier to guard him against terrorists in that fortified castle.

The second husband of Odescalchi's sister was Giuseppe Lancia (not identical with the Italian car manufacturer). The second husband of Prince Miklós' aunt, Princess Alinka Odescalchi (28th April 1882—?), was Pio Lazzari; they had two sons: Pietro and Manfred Lazzari. The wife of Prince Károly Odescalchi (19th September 1896—?), Miklós' cousin, was Countess Klára Andrássy, sister of Katinka Andrássy, Mihály Károlyi's wife. She was killed in an air-raid in Trieste in the winter of 1941. At home she was thought to have been killed there for her anti-fascist activities. The truth is, that she was on her way to England to the Károlyis when she fell victim to the air-raid. She was working for the Allies and when the Germans marched into Hungary she had to flee. She was a fine, brave, talented, by no

⁵⁰ Verbal information by Captain Kálmán Háy and several surviving pilots of the 102/1 air-squadron in 1978.

⁵¹ György Markos: *Vándorló fegyház* (Travelling prison). Magvető, Budapest. 1977.

means ordinary person. Once an ardent legitimist, she was active on behalf of the republicans at the time of the civil war in Spain, and became a passionate enemy of the Nazis and a socialist in the thirties.⁵²

As seen from the above, Miklós Odescalchi's brother-in-law was Italian, and so were his cousins, the Lazzari brothers. These might be mere combinations, but it should be added that through his second wife he had American relatives too. What contact was there between these people and the Hungarian relatives during the war? There is no answer to this question.⁵³

[Here it should be noted that there was a Prince Livius Odescalchi, known as the last proprietor of the Szolcsány estate, who after 1918 was won for the cause of Slovakian nationalism by Jozef Skultéty. They jointly published a document entitled "Zástava veje" (The flag is waving), Slovo Slovákem od národa svojho odvrátenym . . . (Turócszentmárton, 1925). He was an extraordinary character, the only aristocrat in the new Czechoslovak state who declared himself a Slovak. The larger part of his landed property was spared under the land reform passed by the first Czecho-Slovakian Republic and remained in his possession until 1945.]

On the evening of 17th January 1945 Miklós Odescalchi arrived at Sopronkőhida with a group consisting of Lieutenant-General Antal Vattay, the Governor's adjutant-general, Odescalchi's wife (Erzsébet Perczel), Lance-Sergeant Ferenc Bajusz, radio telegraphist and Endre Mélik a journalist, possibly from Transylvania. According to one source it was Vilmos Dominich, Hungarian Nazi judge-advocate, who asked the Austrian authorities for their extradition.⁵⁴

At the time several prominent members of the military, political, social and artistic life of Hungary were in protective custody at Sopronkőhida (Dezső P. Ábrahám, Miklós Kállay, Gusztáv Henney, Lajos Dálnoki-Veress, Géza Töreky, Kálmán Hardy, Kálmán Kánya, Pál Jávör, Ilona Titkos, Prince Nándor Montenuovo, etc.). It was there that István Pataki, Róbert Kreutz and Barnabás Pesti, members of the communist movement, were executed at Christmas 1944, when Endre Bajcsy-Zsilinszky also died a heroes' death.

Odescalchi was thus committed for trial before "the court of the general seconded to the Hungarian Royal Minister-without-portfolio charged with the total mobilization of the nation". (Court of the Chief of the General Staff of the Royal Hungarian Army III.)

He was brought to trial before the ill-famed Dominich division on the morning of 20th January 1945. It is not certain whether he had a defence counsel or whether he had to defend himself. Even if he had some commission, he probably denied it for fear of causing trouble to others. Lance-Sergeant Bajusz was later heard as a witness. When he returned from the interrogation it was still hoped that Odescalchi would not be sentenced to death, as the Army Court had formerly changed several death sentences to life imprisonment. (At Sopronkőhida not a single death sentence was changed; the hope might have been justified by the verdict brought on 8th December 1944 in Budapest, when Pál Almásy, Kálmán Révay and others received a pardon.⁵⁵) József Frisch, first lieutenant, then commander of the military section of the prison, was an ex officio member of the court-martial.

When Odescalchi returned to his cell from the trial he told the clerks (who were allowed to speak to him) that his case was hopeless and he expected to receive capital punishment. One of his fellow prisoners, Lieutenant-Colonel Kapotsffy, who had sewn potassium cyanide into his fur-coat, offered it to Odescalchi so that he could avoid the gallows,⁵⁶ but he refused it.

Next day, at 7.30 a.m. on 21st January, he was brought to the court to receive sentence. That morning Lance-Sergeant Bajusz was set free because the court's verdict was that a subordinate always had to fulfil his superiors' orders without questioning their correctness. Odescalchi's wife was previously released, before the trial began.

It was past nine when he was taken to the condemned cell. A soldier went to the prison office to ask for paper and pen for Odescalchi to write his last will and a short letter to his wife. Finally, he wrote them in the court building. The prison chaplain, Mátyás Geiszbühl, then visited him. The authors feel it important to quote the chaplain's recollections:

⁵² Mihály Károlyi: Hit, illúziók nélkül (Faith without illusions). — Magvető, Budapest. 1977.

⁵³ Attention was drawn to the Italian relations by Dr. Mihály Cenner.

⁵⁴ Jenő Lévai: A hősök hőse . . . ! (Bajcsy-Zsilinszky Endre a demokrácia vértanúja) (The hero of heroes . . . ! Endre Bajcsy-Zsilinszky, martyr of democracy). — Müller Károly Könyvkiadó Vállalat, Budapest. 1945.

⁵⁵ Notes sent to the author by Pál Almásy from his contemporary diary. Details of the diary were later published by András Simonffy in his book "Kompország katonái" (The soldiers of Ferry-land). — Magvető, Budapest. 1981.

⁵⁶ Ibid.

"The Germans handed him over for court-martial at Sopronkőhida with the express order that he should be condemned to death and immediately executed. He was not even granted the usual 2 hours allowed for preparation in the condemned cell, but only half an hour.

I went to him at once and found a man of about 40—45 who was not prepared for death at all . . . He could hardly speak, and asked me to let him finish the farewell letter he was writing to his wife. In the short time available I did everything possible but could not get him to resign himself to the thought of death, if only for lack of time. I accompanied him to the place of execution, where he walked beside me without a word. He was hanged by the neck; shortly afterwards the physician present certified that death had taken place."⁵⁷

The execution took place at about half past nine. The clerks were eye-witnesses to his being led out of the condemned cell and leaving the building. Sub-lieutenant Soós and six bayoneted soldiers escorted him, the condemned man walking between them.⁵⁸ Kálmán Révay witnessed Miklós Odescalchi's last minutes and heard him shouting to his comrades:

"I will not bring shame on you!"⁵⁹

His wife went to the prison next day, which was a Monday. It was then that she learned about her husband's execution from First-Lieutenant Frisch, who gave Odescalchi's belongings to her.⁶⁰

The following is a document unknown to the wider public: a communiqué published in "Honvédségi Rendeleték 11./1945. II. 15." (No. 11./1945. II. 15. of Military Orders) concerning the execution of Miklós Odescalchi, flying officer.

"6th February 1945: Communiqué on the execution of Miklós Odescalchi, flying officer, who attempted to fly over to the enemy.

"On 20th January 1945 Court III of the Chief of General Staff of the Royal Hungarian Army, as a summary court, condemned Prince Miklós Odescalchi, reserve lieutenant of the Air-Force, or treachery, and sentenced him to be hanged by the neck till he was dead; the execution was carried out on the same day.

"Prince Miklós Odescalchi, reserve lieutenant of the Air-Force, committed treachery in that, despite having full knowledge of the martial law which would punish his crime, he abandoned his post in an aeroplane, itself a military secret, with the intention of deserting from the army and of flying over to the enemy to make preparations for the aerial desertion of leading politicians to enemy territory, and of disclosing secrets affecting the important interests and international standing of the Hungarian state; further, he committed treachery by his previous behaviour, making every effort to shake the faith of those around him or in contact with him in the strength and victory of the German army, emphasizing at the same time the certain victory of the Allies; he purposefully tried to do harm to the Hungarian state and the allied German army and ensure an advantage to the enemy, thereby greatly threatening the success of military actions.

"In the present case a member of the aristocracy who swerved from the straight path has received his deserved punishment. Justice has razed his name forever from the minds of the honest Hungarian people who are fighting for the liberation of Hungary. In the national socialist Hungarian state everybody is equal before the law in the true sense of the word. May the case of the person just court-martialled and executed serve as a warning to those who are ready to co-operate with the enemy and sacrifice their nation, country and friends to their own interests. The Hungarian state needs only those who are strong in spirit and will fight for victory with death-defying courage, or who will work with all their strength to build the country anew. Gyepű II., 6th February 1945.

Colonel-General Beregfy manu proprio."⁶¹

⁵⁷ From the letter written on 2nd August 1979 by Mátyás Geiszbühl, parish priest at Fertőrákos, to the author.

⁵⁸ From the letter dated 6th September 1974, Budapest, written to the author by Colonel Lajos Csűrös, former resident of Szolnok, and once a prisoner at Sopronkőhida.

⁵⁹ From a letter of a relative living abroad, who requested to remain anonymous as the source of the data. The author is in possession of the letter.

⁶⁰ From a letter written to the author by Mátyás Geiszbühl, parish priest at Fertőrákos, on 2nd August 1979.

⁶¹ Published in "Hadtörténeti Közlemények" (Bulletin of Military History), and later in Simonffy's book "Kompország katonái" (The soldiers of ferry-land). Magvető, Budapest, 1981.

The original text is a mixture of the contemporary legal and Hungarian Nazi military language, and is consequently laboured.

On 18th February 1945 the arrows "Győri Nemzeti Hírlap" (National Journal of Győr) (editor: Jenő Pohárnok) published a defamatory article⁶² under the title "Prince on the rope" fundamentally based on the above communiqué and the report from the Hungarian Telegraph Bureau, but it did not contain any details of the preliminaries of the flight.

The documents of the court-martial were destroyed in Germany in 1945, so the main issue of the trial, namely, whether he was found guilty as a deserter who went over to the enemy, or condemned for participation in the attempt to take Hungary out of the German camp, is not known. No record of the text of the sentence and the reasons given for it has remained. However, from the order signed by Colonel-General Károly Beregfy, one may conclude that he was condemned as a deserter, for taking an aeroplane over to the enemy and for preparing further escapes.

Between the two wars Prince Miklós Odescalchi did not play any spectacular role in the historical life of Hungary, but in the most critical times he had the courage to make a positive decision, and he paid for it with his life.

In 1945 Colonel-General János Vörös, then War Minister, promoted Miklós Odescalchi, reserve lieutenant of the Air-Force, to post-mortem major. His body was exhumed at Sopronkőhida and transferred to Budapest. The funeral service took place in the middle of December 1945, in the Franciscan Church, Budapest, and at the same time an obituary was published (Fig. 7).

Some time at the end of December he was buried at Tuzsér with full military ceremony; Ernő Marosi, the parish priest, officiated at the service. Miklós Odescalchi rests in the front part of the graveyard, between his daughter and second wife. The grave is unmarked except for an iron cross, and all three graves are unkempt. On All Souls' Day candles are lit on his grave by unknown hands. (The exact date of his burial could not be discovered.)

After the liberation of the country a memorial pamphlet was published with the names of those martyred at Sopronkőhida. Miklós Odescalchi's name was fourth in the list. The front-page was illustrated with a stone vessel with a tongue of flame in it and the poet's lines below:

"Az nem lehet, hogy annyi szív
Hiába onta vért,
S keservben annyi hű kebel
Szakadt meg a honért."

(Mihály Vörösmarty)

(It cannot be in vain that blood
by so many has been shed,
and so many faithful hearts have broken of
grief for the motherland.)

The original memorial tablet at Sopronkőhida was removed in 1950 and replaced by one showing the name of Endre Bajcsy-Zsilinszky alone. Lieutenant-General Pál Almásy later found the original tablet in a store-room. On the 30th anniversary a new one was made, but the list of names is both incomplete and incorrect; Miklós Odescalchi's name is missing. One wonders why — because he happened to be a prince?⁶³ Maybe he was forgotten on purpose by an ungrateful posterity. May this work be a flower on Miklós Odescalchi's grave.

Acknowledgements

It is not considered necessary to make detailed references to the sources, particularly those used in the historical section, so only the bibliographical data are given. In the case of recollections the names of those supplying the data are indicated; some people did not give permission to publish their names. Some of those called on were reluctant to give informa-

⁶² Prince on the rope. — Győri Nemzeti Hírlap, 18th February 1945.

⁶³ Personal information from Lieutenant-General Pál Almásy.

tion, saying that "they were too young then", others simply refused. At the same time, thanks are expressed to those who, realizing the importance of the subject, helped the authors in their work in an unselfish manner (sometimes anonymously).

K. NYÉKI, GY. SÁRHIDAI

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Addendum

After going to press, the following new information on the subject was discovered.

One of the participants in the flight to Italy on September 22nd 1944 with the purpose of requesting a ceasefire was László Rákosi Sr., who died in Budapest in 1980. Due to his personal acquaintance with the family, who were aware of the nature of his research, the author was granted access to the papers and memoirs of the deceased before they were handed over to the Budapest Military Science Archives for safekeeping.

According to these papers, a delegation acting on the orders of Governor Miklós Horthy left Csákvár at 17.00 hours on September 22nd 1944 in a He-111 H-6 aircraft bearing German markings and belonging to the Air Force Transport Squadron, with the intention of negotiating a ceasefire at the Allied Headquarters for Southern Europe in Caserta, Italy. The crew consisted of the pilot, János Majoros, chief engineer (MALÉRT), reserve flight lieutenant; the radio operator József Marosán; and the navigator and rigger László Rákosi. The passengers were Colonel-in-Chief István Náday; Colonel J. F. Howie of the British Artillery, a prisoner-of-war kept secretly in Buda Castle;

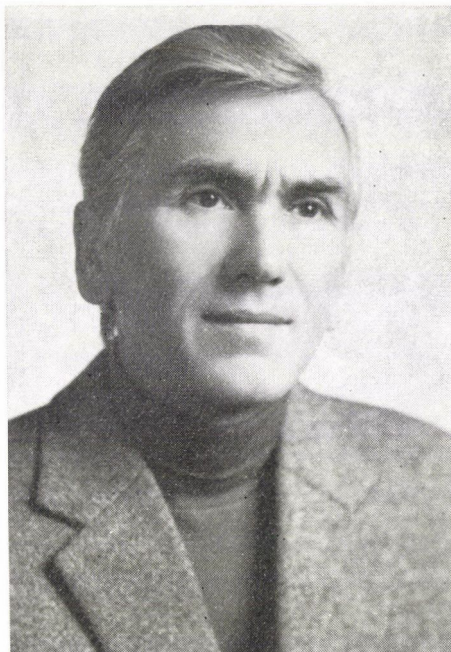
and the wife of János Majoros. The plane did a belly-landing at Barletta, near Foggia at 20.00 hours local time on the same day. The plane was severely damaged, but the delegation escaped unharmed. On September 24th 1944 Colonel-in-Chief Náday removed the documents from the plane under American escort, at which time he made the following statement in the hearing of the aircrew: "If Count Odeschalchi's flight had succeeded, the aircraft would not be in this state. His task was to make preparations for this flight by getting the necessary codes out of the country."

Since László Rákosi Sr. never made any mention of this incident to the author during his lifetime it was impossible to follow up the matter. His use of the title Count was obviously a mistake, but this is understandable, as he was not familiar with the upper circles of society, and the lines in question were written 35 years after the event.

This is the first and as yet only definite indication that Prince Miklós Odeschalchi, reserve flight lieutenant, played an active part in the military resistance.

Gy. SÁRHIDAI

AS I SEE IT . . .



PRESENT AND FUTURE OF GRAPE PRODUCTION IN HUNGARY

The progress made recently in the whole of Hungarian agriculture can be put down to the technical and technological development, particularly to the choice of varieties and to the widening of the range of varieties available.

Since the technical, technological and biological factors characteristic of traditional vine-growing have changed now that grapes are grown under large-scale conditions, the yield averages, particularly in the state farms, have significantly increased. Where this technical and technological change has not taken place, the production level and yield averages are more modest.

It is quite clear that the revolutionary change which has taken place in vine-growing makes it possible for production to be carried out on a quite different scale, though grapes are still not produced under intensive conditions in all sectors of the farm community.

Since intensity is a relative concept, and since for any given crop or branch of agriculture intensity is measured by comparison with earlier conditions, it is necessary to give a brief survey of the traditional factors of vine-growing, which unfortunately still exist on large areas and represent the root of the problem. It should be noted that in writing this article the author has made use of the results and publications of numerous Hungarian authors and farms, as required by the reviewing and synthesizing nature of the paper. These sources have not been cited individually due to the extremely large number involved.

In traditional vine-growing intensity meant a large input of manual labour (170-310 workdays per ha) and, from the biological point of view, the utilization of the area by a large number of plants (5-10,000/ha) with a suitable composition of varieties.

After the introduction of wide-spaced, high-growing cultivation these traditional views survived and acted deleteriously not only on the production policy but also on the technique and technology of vine-growing.

This period was characterised not only by the attainment of new experience but also by attempts ending in failure, as they were based on false premises.

It is evident that intensive production is impossible with the old traditional technology, type of plantation and variety, and under inadequate ecological conditions.

Today it is obvious that in general the acclimatisation of the frost-sensitive varieties grown on the major part of the Hungarian vine area to high-growing cultivation has not brought the desired success, and the experience thus obtained seems to indicate that without eliminating outdated notions the contradiction between traditional cultivation and intensive production cannot be resolved.

For well-known reasons, when a longer period is taken into consideration the amount of input per unit area continuously increases, and an ever larger yield is needed if the prime cost of production is to be acceptable.

On the basis of yields and inputs the lower limit of output was determined 10—12 years ago as 4.0—4.3 tons/ha. Later, with approximately the same purchase prices taken for basis, this was raised to 5.0—5.5 tons/ha. The yield level today is 8.0 tons or more.

Since no significant reduction in inputs is possible in large-scale production, and in fact, in up-to-date intensive production there is even justification for a reasonable increase in inputs with a view to larger yields, it is clear that a substantial increase in yield averages is the only solution for vine-growing. The achievement of this objective is influenced and in some cases delimited by a number of factors.

"The plants under cultivation and the technological procedures form a coherent system depending on the growing site conditions, and the role of the growing site may have a decisive influence on the production processes." From this it follows that the environment imposes biological restrictions on intensive production.

If the peculiarities of up-to-date vine-growing are analysed according to the above, it can be established that

- intensive vine forms and the vine varieties suitable for producing them only give maximum yields under adequate ecological conditions,
- a well-chosen growing site plays a more important role in intensive production than in traditional production.

This means that the application of intensive vine forms and the varieties suitable for producing them requires environmental conditions which impose the least possible restrictions on the yield potentials.

If this is so, as indeed it is, the weather conditions determined by the local climate are the most important factors in intensive production; in particular, winter and spring frosts, and the autumn weather conditions that largely influence the quantity and quality of yield are the decisive factors.

It is thus indispensable for future research to formulate the requirements to be met by the production technology and varieties which suit the meteorological factors and the criteria of up-to-date intensive vine-growing.

Accordingly, intensive varieties and production technologies are those which, under the given climatic conditions, utilize the optimum nutrient content of the soil in such a way that they satisfy not only the economically desirable quantitative requirements but the qualitative requirements, too.

Major characteristics of grape production

The vine area of Hungary is decreasing year by year. It was 246,563 ha in 1965, 185,703 ha in 1978 and some 165,000 ha in 1980. The average annual rate of decrease was 4000—5000 ha, and this rate accelerated in 1975—80, particularly in certain wine-growing regions. It is reassuring that the reduction in area is not characteristic of the state farms or of the private sector, which includes many small producers.

- The production structure has improved in recent years, but is still unfavourable:
- the proportion of vine areas suitable for large-scale production in the state and co-operative farms makes up more than one-third of the total vine area, while two-thirds belong to small producers, household plots and other sectors (Table 1);
 - the regional distribution of grape production needs to be re-examined as regards site suitability; the area of low-lying vineyards exposed to frost damage is larger than desirable, which is one reason for the high annual fluctuations in the yield averages of wine regions and farms (Table 2);

- some 40,000 ha of the vine area of Hungary is planted with up-to-date, large-scale vineyards where the vines are cultivated on high wires, and where the possibility of mechanization means that the manual labour demand can be considerably reduced; at the same time at least 100,000 ha are occupied by highly labour-intensive, close-spaced vineyards using the low, head and ridge systems of cultivation, planted with a variety of vines, most of them with decreasing productivity;
- yield stability, farm organization, up-to-date technology and techniques, and the production of high quality wine raise ever increasing demands on the vine varieties to be grown; the present variety structure is less and less able to satisfy these criteria and the favourable change in the structure needs to be accelerated because of the low proportion and rate of new plantations and the irregular supply of propagation material

Table 1*Distribution of vine-growing in Hungary according to production sector*

	ha	%
State farms	21,792	10.9
Other state-owned areas	4,797	2.4
Co-operative farms		
collective cultivation	43,681	21.9
share cultivation	3,710	1.8
private cultivation	48,483	24.3
Total:	95,874	48.0
Other co-operatives		
collective cultivation	5,318	2.6
private cultivation	22,886	11.4
Total:	28,204	14.1
Subsidiary farms owned by the population	49,176	24.6

The average grape yield, which expresses the efficiency of production per unit area, has almost doubled in the state farms over the last 15 years and now equals the yield averages obtained in the leading vine-growing nations of the world, i.e. 7.5–8.0 t/ha. There has also been a significant increase in yield average in the cooperative farms, though the trend is slower. All in all, more grapes are grown in Hungary today than fifteen years ago, on an area which has decreased by almost half, a fact which definitely deserves attention.

At present the grape production of Hungary still requires a high manual labour input, at a time when there is a natural decrease in the agricultural labour force each year. The cultivation of vines requires an annual 1000–1200 work-hours/ha under small-scale conditions. In the considerably more up-to-date system of cultivation employed in large farms, the manual labour demand is 600–800 hours/ha/year. On large integrated areas, however, cultivation methods, production technologies and mechanization have been evolved which, if introduced, would reduce the manual labour utilization to 300–400 hours per ha.

Major characteristics of wine production and trade

The total annual wine production of Hungary between 1970 and 1978 was 4.5–5.5 million hl.

Wine consumption in Hungary has stabilized at a level of 35 litres/capita a year since 1975, while the consumption of beer doubled between 1965 and 1978.

Table 2

Distribution of vine-growing areas in hectares according to wine region and variety groups

Wine region	Quality white wine varieties	Common white wine varieties	White wine varieties in mixed plantations	Red wine varieties	Table grape varieties	Scions
Great Hungarian Plain	8,655	40,880	8,839	29,661	2,335	24
Badacsony	1,383	32	980	—	—	—
Balatonfüred — Csopak	1,252	29	694	26	22	—
Lake Balaton district	1,021	115	815	13	20	—
Foot of Bükk hills	2,266	23	196	20	835	—
Eger	973	72	524	595	213	79
Foot of Mátra hills	2,636	305	872	121	2,409	20
Mecsek hills	329	27	855	28	60	—
Mór — Császár	602	1,521	160	—	45	—
Somló hill district	226	26	168	—	5	—
Sopron	224	—	51	916	14	36
Szekszárd	151	55	107	1,311	114	42
Tokaj Hegyalja	5,281	—	1,135	—	—	50
Villány hill district — Siklós	594	147	111	909	227	42
	2,279	1,029	3,035	433	979	—
	2,602	6,149	10,832	4,510	8,334	431
Total:	30,474	50,417	29,374	38,543	14,612	724

With regard to volume and as a proportion of total exports wine exports have shown a steadily increasing tendency in recent years; in 1978 the volume of exported wine exceeded two million hl, of which 80% went to socialist countries and 20% to capitalist markets. The proportion of bottled wine is 51%; the increase in the volume of exported champagne and vermouth proves that the product structure has been modernized, resulting in better adaptation to market demands.

The per capita consumption of grapes is low (6–7 kg), and no substantial increase has lately been observed; production in private gardens and household plots may modify this consumption level to some extent, but the latter cannot be expressed in figures.

The production and consumption of soft drinks made from grape-juice have lately shown very dynamic growth, parallel with a development in the production and consumption of other soft drinks; a favourable picture is also offered by the widened range of products of this kind: Márka, Traubisoda, Vitis, Boglári grape juice, etc.

Some important economic problems of grape and wine production

For a long time economic restrictions have not had a sufficiently incentive effect on the maintenance, and particularly the development, of production branches which require large investments and manual labour utilization and have high prime costs. This is also true of viti- and viniculture, since

— the establishment of 1 ha of up-to-date vine plantation requires 250–300 thousand forints, while a further 100 thousand forints have to be spent on the construction of the necessary storage and processing facilities and an additional sum of 30–50 thousand forints is needed for mechanization and other accessories, amounting to a total investment of 400–500 thousand Ft/ha;

— owing to rising industrial prices the prime cost per ha rises from year to year, and the specific production cost already exceeds 40,000 Ft/ha; the yield must be at least 8.0 tons/ha if the prime cost for the farm is to be the acceptable 5000 Ft/ton of grapes.

At present even large-scale vineyards require a labour input of 600—800 working hours/ha a year, and any reduction in this can only be achieved with a considerable additional input of assets, combined with modernization of the vineyards and mechanization of the production processes.

To carry out an adequate extent of renewal and technical modernization (including processing) development funds of some 10—12 thousand Ft/ha should be accumulated each year, assuming that vine-growing is self-financing. Under the present conditions only the most successfully managed farms are able to do this.

In farms with the full vertical system of wine-making it has lately become more difficult to make a profit, since an increase in the production costs has been accompanied by government curtailments and a reduction or withdrawal of export dotations.

At home the retail price of wine includes some 24—25% turnover tax and 15—18% retail trade price gap, which is extremely high, while the income level, proportional to assets, of the farms which run the risk of production and bear the burden of the investments is hardly sufficient to maintain production funds.

Some important questions of long-range development in viti- and viniculture

The national economy must bear in mind the fact that the development of viti- and viniculture and the modernization of production, even at the present level, requires a steadily high level of investment. The way in which long-range objectives are formulated also determines the extent of future development in vine production as a whole. Some long-range development objectives can be defined as follows:

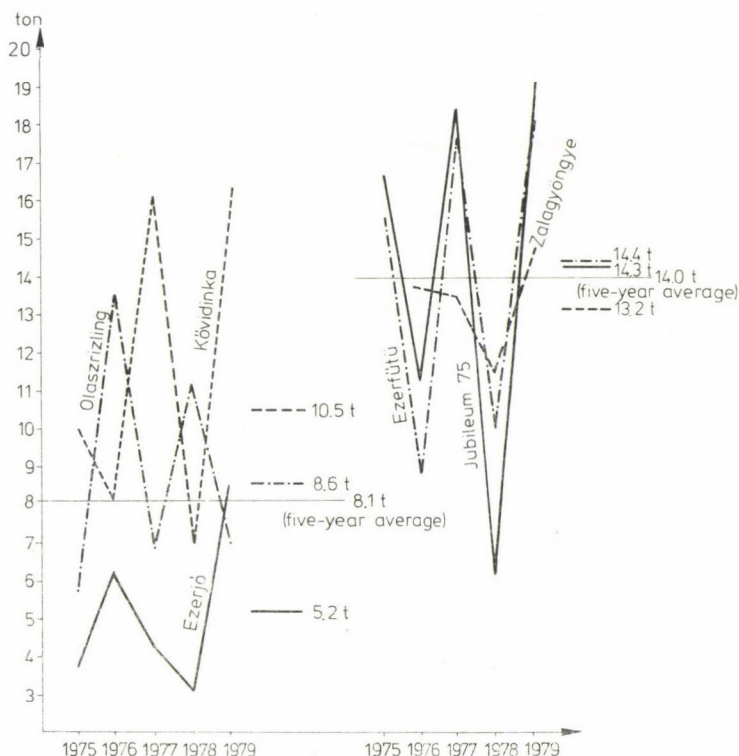


Fig. 1. Volume of yield in traditional and new varieties

a) It can be expected that in the long run the domestic consumption and foreign market demand for wine and wine products will not encourage any significant quantitative increase in grape yields. On the other hand, the transformation and modernization of production and the product structure, the wider general application of quality-improving technologies and processing methods, and a more rapid increase in management efficiency will become key issues for the whole system of production, processing and trade.

b) The long-range objectives in vine-growing would be realized in practice if an annual total of some 1 million tons grapes, which would satisfy the requirement for basic materials, were produced in Hungary on an area of 120—130,000 ha with a realistically attainable yield average of 8.0—8.5 tons/ha (Fig. 1).

c) The well-organized establishment of new vineyards on 20,000 ha every five years, giving a total of 80,000 ha by the end of the century, would result in the elimination of many of the present problems and a lessening of other drawbacks. The expected consequences would be a significant increase in yield stability, the elimination of differences in production level from one year, farm or sector to another, the adoption of modern techniques and technologies, favourable changes in the biological background and varietal structure, and increased farm and area concentration in optimum vine-growing regions, which would add up to a return of the value of the assets invested and the annual production costs (Table 3).

Table 3

Frost damage to light buds in winter, and volume of yield in traditional and new varieties

Variety	Spring 1976		Spring 1977		Spring 1978		Spring 1979		Spring 1980	
	bud loss, %	yield, t/ha	bud loss, %	yield, t/ha	bud loss, %	yield, t/ha	bud loss, %	yield, t/ha	bud loss, %	yield, t/ha
Ezerj6	58	2.16	87	1.91	96	2.42	29	5.66	13	12.52
Kadarka	78	0.79	85	3.17	100	1.84	29	8.31	47	3.35
Ezerf6rt6	31	8.92	62	17.98	56	10.00	31	18.71	17	18.47
Jubileum	5	11.3	6	17.18	19	5.93	7	19.21	13	15.28
Zalagy6ngye	14	13.70	9	13.60	27	10.80	12	14.90	7	16.00
Lowest rad. min.	-21 °C		-24 °C		-21 °C		-18 °C		-18 °C	

If long-range objectives are to be achieved, the following criteria must be met:

— economic regulators should have a continuous, permanent but selective stimulating effect over a longer period on the establishment of vineyards, as foreseen in the national economic plans;

— planning and preparation should be raised to a higher standard and take longer periods into consideration: e.g. by elaborating new development programmes for the regions or by modernizing and adjusting the existing ones;

— up-to-date forms of co-operation between farms should be further developed, with particular emphasis on the types of enterprise and farm co-operation which meet the special requirements of viti- and viniculture.

The technological conditions for up-to-date intensive vine-growing

Since the beginning of the sixties the production technology has been characterized by the following:

— the introduction of wide row-spacing in the early sixties made the use of high capacity machines for plant protection and soil cultivation possible;

— the cultivation of the vines along high wires, which began during the same period and became general practice from 1965—66, facilitated among other things the application of contact herbicides and the improvement of all technological operations;

— mechanical harvesting became an integral part of the technology from the early seventies onwards and necessitated considerable further development in the plantation structure and trellis system;

— today the phytotechnical operations are the weak points of the technology, and the increased mechanization of pruning is also a task which is yet to be solved.

The complex analysis of the considerable change in the existing variety composition is no small task either. The farms need varieties which, besides adequate frost resistance, reach an advanced stage of maturity in early or mid-September, when a period of rainy weather almost always occurs. Therefore, the composition of the varieties used in Hungarian grape production is necessarily shifting towards earlier varieties.

Correlations between the variety and the cultural practices have also been revealed by modern methods of cultivation, proving that the variety should be chosen to suit the technology, rather than the technology adjusted to the existing variety.

Since, as a concomitant of development, a great variety of row and plant distances, supporting systems, cultivation and pruning methods have been employed over the last twenty years, and even the first large-scale vineyards have been modernized in different ways, the present forms of plantation and the technologies applied show various peculiarities.

The up-to-date basic principles summarised below can be applied in full in newly established vineyards and in part, depending on the special conditions, in existing vineyards.

Construction and maintenance of trellises

At present the bad construction of the trellis system is the greatest hindrance to technological development in most large farms. Among other things it prevents the favourable spatial distribution of the foliage and fruit and hinders mechanical topping and harvesting.

In order to promote the improvement and simplification of the technology, the supporting system must satisfy the following criteria:

— the poles must be strong (about 12–14 cm in diameter) and should be placed not farther than 8 m from one another;

— the poles should be suitable not only for holding the wires, but also for fixing and training the vines;

— the wires holding the branches should be placed at a height of at least 150–160 cm;

— there should be as few as possible wires to hold the shoots.

These criteria are best fulfilled by twin-vine (220 + 20 cm or 280 + 20 cm) trellises where every second or third vertical support is a strong wooden pole, while those in-between are strong stakes or quartered poles.

A single wire or pair of wires at a height of 180–210 cm is sufficient to support the shoots, while the wire holding the branches is placed at 150–160 cm.

The experience gained in farms which have developed the best methods of constructing and maintaining supporting systems should be propagated all over the country by means of demonstrations and publications.

Complicated solutions should be avoided.

Pruning, etc.

In intensive vine plantations the productivity of the buds can be considerably increased. Vines grown on high supporting systems can be loaded with high productivity axillary canes and their buds by the third year of training.

In the course of pruning the importance of long elements further increases. This is the main justification for raising the branches higher.

Of the various vine cultivation methods, the Sylvoz-type cordon system and the so-called umbrella method are the most popular at present. With these methods short spurs need not be left on the vine.

The above points must be kept in view when planning plantation or reconstruction with the varieties recommended for the different wine regions.

At present the following four vine forms are considered promising:

— terminal shoot cultivation,

— Sylvoz cultivation,

— high cordons with free shoots,

— high cordons pruned to long spurs.

When deciding the extent of bud load the condition of the vine, the variety, the productivity and state of health of the buds, and the purpose of production must be taken into consideration.

Proposed bud load:

— terminal shoot cultivation	6—9 buds/m ²
— Sylvoz cultivation	10—12 „
— high cordons with free shoots	10—14 „
— high cordons with long spurs	10—14 „

The determination and maintenance of optimum load, which depends on the nutrient status of the soil, the condition of the vine, the characteristics of the variety, etc. are important phytotechnical tasks. The optimum load may range between 8 and 14 buds/m².

The yield per ha can be reliably planned to be 10—12 tons in small-clustered varieties (e.g. Chardonnay, Szürkebarát) and 15—16 tons in large-clustered varieties (e.g. Rizling-szilváni, Zalagyöngye).

In addition to a technically well-constructed trellis system, a favourable spatial distribution of the bearing shoots (hanging and fixing them below the wire supporting the branches), early and repeated topping of the shoots, wider spacing (1.50—1.60 m) in varieties with very dense foliage and — with a view to balanced production — repeated selection of the shoots are needed to avoid the harmful consequences of self-shading.

The clusters should be placed so that they are exposed to the sunshine throughout the growth period.

Good bud differentiation is also determined primarily by sunny, well-ventilated foliage.

Mechanical harvesting and efficient plant protection also call for relatively thin or loose foliage.

Pruning, etc. can be simplified by preventing the shoots from clinging to the wires and to each other.

The realization of this fact led first to the replacement of the two pairs of wires by one pair of wires, and recently to the use of a single wire to support the shoots, and to the introduction of single and double curtains, e.g. supporting systems without wires for the shoots.

In spite of these developments it is quite clear that vines cannot be grown without a certain amount of manual labour even in large-scale farms.

A carefully cultivated, smooth soil surface and a well-constructed supporting system are the principal preconditions for mechanical topping.

The mechanization of pruning is becoming more and more efficient, yet, since in the case of the grape-vine the quantity and quality of yield are determined by the number of buds left on the vine after pruning, mechanical pruning will always require manual correction.

Increased attention should be paid in the future to a broader knowledge of the biological basis for phytotechnical operations, since it is the incorrect execution of these operations that makes a further increase in yield and improvement in quality difficult in large-scale vineyards.

Soil cultivation

If the vineyard is to get a good start, with the rapid development of large bearing surfaces, deep ploughing before planting, an abundant supply of nutrients and plant material of high biological value are needed.

In the years following plantation the vine develops a large root system penetrating a wide area of nutrition, so earlier principles concerning soil cultivation require considerable modification.

First of all, the less the soil is disturbed, the better.

In the future a perfectly smooth soil surface should be developed between the rows in order to enable machines carrying out delicate operations (topping, harvesting) to work more efficiently. Another fundamental requirement is to co-ordinate the chemical weed control around the stems, minimum surface disturbance between the rows and the carrying out of periodical deep cultivation.

With a view to easing the work of tractors and machinery, to allowing plant protection, harvesting, pruning, etc. to proceed even in rainy weather, and to reducing the extent of erosion, it is reasonable to maintain natural weed growth or planted vegetation between the rows. In these strips crushed vine-shoots can also remain on the surface, and some of the fertilizer is spread over them. The right intercrop should be chosen according to the water regime of the soil.

Deep tilling is an important element of soil cultivation and cannot be omitted from vine-growing technology, at least according to our present knowledge.

With a row-spacing wider than 3 m, deep tilling can be carried out adequately. It plays an important role in loosening soil packed hard by tractors and in making the nutrients easily available.

Great attention should be paid to herbicide rotation, as in many vine plantations the high triazine content has already made its harmful effect felt.

Soil cultivation and fertilization are gradually becoming a group of operations included in a uniform system.

The use of machinery which is designed or adjusted to form hills at the base of the row should be avoided, as these make the removal of suckers difficult and decrease the efficiency of chemical weed control.

In twin-vine plantations the clearing of the bases of the rows with implements furnished with automatic sensing-devices (mechanical cultivation) should be urgently solved by importing machines. This is justified, among other things, by the increasing price of herbicides.

Nutrient management

The scientific principles of nutrient management are apparently laid down by regular soil and leaf analyses.

In spite of this there are many contradictions in this field. Further rationalization of nutrient management is justified by the necessity to economize with money and materials and to check environmental pollution while there is still time, and by the more and more frequent appearance of the unfavourable biological and production consequences of an over-abundant and possibly one-sided nutrient supply.

According to experience obtained in Hungary and abroad, basic fertilization before plantation ensures the necessary nutrient content of the soil for a long period (5—10 years). (As to the extent of the nutrient supply, moderate tendencies have recently become dominant.)

The co-ordination of nutrient replacement and pruning, etc. is particularly important. Organic fertilizers are used primarily in the form of basic nutrition.

The utilization of nutrients is favoured by the retention of cover crops, by leaving prunings in the row-spaces and by spreading some of the inorganic fertilizers over the cover crop.

Foliage sprays containing microelements continue to have an important role, and the application of liquid manures and fertilizers is being increasingly encouraged.

Plant protection

For vineyards bearing fruit there is a well-established plant protection technology.

Attention should be called principally to the importance of keeping to the optimum spraying date and choosing the most suitable sprays.

The efficiency of plant protection by aircraft and land machines is generally satisfactory, but the control of botrytis, grape-berry moth and leaf mites demands special attention. Efficient protection against these — as well as against viruses — can only be achieved with machines working on the ground.

The efficiency of plant protection can be greatly increased by phytotechnical operations. If for no other reason, a well-ventilated, fairly thin wall of foliage should be developed and maintained.

In increasing the efficiency of plant protection a primary task is to produce hybrids fully or partly resistant to one pathogen or other by interspecific or intervarietal crossing. In order to reduce the number of sprayings the use of systemic pesticides with prolonged action should be urged.

Replacement of vines

The replacement of vines which have decayed has been neglected in comparison to the high rate of establishing new vineyards. With a view to the rapid return of inputs, the replacement of vines should definitely be carried out in intensive commercial vineyards.

Considering the adverse effect of shading, in fruit-bearing vineyards grafts in containers are suggested for use as replacements.

Provided plastic tubes are used to protect the young vines, contact pesticides can safely be used for the chemical treatment of the rows.

To eliminate the adverse effects of shading and to allow chemical treatment to be carried out regularly at the bases of the rows, the use of two-year-old, short-stemmed replacement vines raised in containers should be introduced in practice.

Harvesting

Among the manual harvesting methods the wider introduction of plastic crates, collecting bins and containers should be urged.

A more rapid development in mechanical harvesting would be justified all over the country. In many farms the existing machines are not efficiently utilized at present, not only for financial and organizational reasons, but also due to false concepts.

The organization of the harvest is greatly influenced by the autumn weather, and is begun more and more often in September, in spite of the fact that the varieties required for an early start are not grown in most farms.

A further rapid improvement in the vine variety structure in Hungary is urgently needed, not only due to the necessity to produce basis material of adequate quality, but in the interests of yield stability.

Summary

Grape production in Hungary has undergone revolutionary changes over the last twenty years. The traditional method of cultivation has been replaced by intensive cultivation on high wires. The nutrient management is systematic and based on well-established scientific principles. The mechanization of the major processes of vine-growing has made considerable progress, though there is still much to be done in this field; for harvesting, pruning, etc. in particular, the level of mechanization is lower than desired.

Hungary is excellently suited for quality wine production. It is a pity that certain economic and policy factors which have a negative effect on the stability and quality of production continue to cause problems; as long as these are in effect major, decisive professional questions cannot be settled. These are:

- the planting of favourably situated hills and slopes with vines imposes great burdens upon the farms, and they are therefore neglected. State benefits are required to change this tendency;

- the use of up-to-date varieties is an indispensable precondition for developing the intensive character of vine-growing. Good quality early or medium early varieties giving a reliable yield are needed to replace the old varieties which do not possess these properties. In vine-growing, as in every branch of agriculture, full exploitation of the ecological potential is an imperative necessity.

The technological discipline must be increased in every respect! The completion of operations in due time and quality is a guarantee of economical production.

It cannot be overlooked that vine is a labour-intensive crop. Certain elements of manual work may be partially or even fully replaced by machines, but some operations must be carried out exclusively by hand, and the individual handling of the grape-vine is an indispensable precondition for intensive vine-growing.

With this in view any initiative which will make this activity possible must be encouraged and sponsored. It is particularly important to increase "large-scale household plot" vine-growing: grape-vines planted with the assistance of a large farm (machine, propagation material, etc.) but cultivated privately.

An increase in the personal incentives to regularly produce high quality grapes and wine would be advantageous for the whole of society, and would form the basis for fulfilling the ever greater export and domestic requirements.

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LECTIONES

GRAIN PRODUCTION AND THE FUTURE OF THE HUMAN RACE*

1. Population growth and food production

The word cereal can be used to designate either the whole plant or just the grain. Grain is a generic term which can be applied to any kind of cereal. The cereal crops: wheat, rye, barley, oats, rice, millet, maize and sorghum, all belong to the botanical family Gramineae and are cultivated by Man chiefly for their edible grain yield, which is rich in starch.

Approximately 60% of the total calories and 50% of the protein in the human diet come from the direct consumption of grain, while a considerable proportion of the remainder is of similar origin, since it is derived from grain used as animal fodder and thus consumed indirectly by humans. Cereals are grown on about half the total arable area of the world.

Without disputing the role and significance of food sources of non-cereal origin, the figures given above would seem to justify us in taking grain production as the starting point for an examination of the situation and prospects of the human food supply and in contrasting the development and latent possibilities of grain production with the rapidly increasing food requirements of the human population, which is itself increasing at a startling rate.

Forty-five years were required for the last doubling of the human population, from around 2 thousand million in 1930 to 4 thousand million in 1975. But considering the slight reduction in the rate of population growth over the last few years, the next doubling of the world population will probably occur in 50-75 years' time, depending on the growth rate; in other words, not later than the middle of the next century. Only if the food production can be doubled in a shorter period than this will there be a relative improvement in the human food supply.

The task is really colossal: it means that within the next few decades the increase in the food production of the world must be at least as great as that experienced during the 12,000 years from the beginning of agriculture to 1975, and even then this will only maintain the present per capita food supply, which can hardly be called satisfactory. There is a burning necessity to exceed this target by as much as possible, because there are already 500 million starving people in the world, and many times more who are underfed.

Of course, the solution of the world food problem does not depend solely on the total amount of food produced, but also on numerous other factors, above all on the distribution of the available food. But food cannot be distributed until it has been produced! Consequently, and because grain production is our theme, I shall concentrate on this alpha and omega of food production.

Can grain production be doubled within the next half-century or so? Is this aim realistic? Is there any proof, or a serviceable analogy from the recent past, to show that it can be achieved? The examples given below may perhaps justify a certain optimism.

2. Ways of achieving a rapid, major increase in grain production

The history of maize production in the United States of America over the last 50 years is the most convincing example of the fact that grain yields can be doubled within a few decades. The story began with the spread of hybrid maize seed. This process, which started slowly at the beginning of the thirties, gathered momentum towards the end of the decade.

* A lecture delivered at the Round Table Discussion "Food Production—Nutrition—Health" held by the Royal Swedish Academy of Sciences on January 20-23, 1981 in Uppsala, Sweden.

Table 1

Five-year averages of maize yield and nitrogen fertiliser applied in the USA
(Compiled by Roswell Garst using USDA data, with the exception of the figures for the last five years)

Year	Sowing area of maize harvested as grain in 1000 acres	N active agent applied in 1000 tons	Average yield/acre in bushels	Total grain yield in 1000 bushels
1930—34	103,404	281.6	21.9	2,023,906
1935—39	92,899	371.2	25.0	2,050,232
1940—44	90,083	466.5	31.9	2,604,631
1945—49	85,696	778.3	35.6	2,771,638
1950—54	78,586	1,429.8	38.5	2,787,849
1955—59	66,409	2,197.0	48.7	3,234,891
1960—64	59,876	4,031.7	62.5	3,722,910
1965—69	56,728	5,948.3	78.5	4,453,489
1970—74	61,215	8,205.5	84.0	5,135,361
1975—79	70,088	10,054.4	94.9	6,657,795

It is noteworthy that while the sowing area has decreased by a good 30% the total yield has increased three and a half times

Table 2

Wheat yields in Hungary

Year	Average yield	Increase in average yield		Increase in average yield compared to that in 1952—56 (≈ 1934—38)	
	over five years				
	q/ha		%	q/ha	%
1934—1938	14.0				
.					
.					
.					
1952—1956	13.9				
1957—1961	16.3	2.4	17.2	2.4	17.2
1962—1966	19.1	2.8	17.2	5.2	37.4
1967—1971	26.2	7.1	37.2	12.3	88.4
1972—1976	34.9	8.7	33.2	21.0	151.1
1977—1980*	40.8	5.9	16.9	26.9	194.2

* Average yield over four years only

Table 3

Main factors in the good two and a half times increase in Hungarian wheat yield averages over the last twenty years

Exchange of varieties	Bezostaya and other foreign and domestic intensive winter wheat varieties instead of Bánkúti
Artificial fertilisation	Tripled: approx. 200 kg/ha active agent by the beginning of the seventies
Mechanisation	A large number of modern combines instead of hand scythes and a reduction in harvesting and storage losses
Professional knowledge	Approx. 10,000 new, university-trained experts and the unconditional authority of the experts in professional matters
Economic policy	As a result of the economic reform, as much financial incentive and self-determination as is possible in a planned economy

In 1930 only a fraction, 0.02%, of the maize seed sown in the USA was of hybrid origin, and this ratio was still only 10% in 1936, but from then on only a brief decade was required for it to reach 80% by the mid-forties.

The spread of hybrid maize and of mechanical pickers had a mutually stimulating effect. The pickers could only work efficiently in strong-stalked, standing maize fields; the use of the picker, on the other hand, raised the maize-producing potential of the farms, as they were no longer restricted by the 100 bushels/day capacity of the manual pickers. Thus it is hardly surprising that the fifteen years from 1930 to 1945 saw the triumph in the USA not only of hybrid maize seed but also of the mechanical picker, both of which gained ground from virtual non-existence to almost universal application.

Meanwhile it became obvious from experiments on hybrid maize that there is not much use in developing high-yielding plants if the nutrients required for the expression of the yield potential are not provided, nor is there much sense in providing crops with abundant nutrients if the plant lacks the genetic potential to utilise the nutrients. The emergence of fertilisation as the most efficient yield-increasing technique in American farming circles was facilitated by the fact that from the end of the forties the American explosives factories went over to fertiliser production, so there was no shortage of cheap nitrogen fertiliser.

As intensive fertilisation gained ground, more and more farmers planted maize in their best fields year after year without rotation. This in turn necessitated effective soil insecticides, while efficient herbicides were required to overcome the weed growth stimulated by fertilisation.

The cooperation, based on free enterprise, which arose between the farmer and various specialists, professions and industries, turned American agriculture into a horn of plenty. With a certain degree of simplification, the specialists, professions and industries serving the farmer can be classed in three categories: the geneticist, who breeds new plants and animals, the chemist, who produces new chemicals, and the engineer, who rationalises and mechanises farm work. American agriculture, the result of this cooperation, can rightly be described as the greatest triumph of American technology, as is well illustrated by the 5-year averages for maize yields and the amount of fertiliser utilised in the USA during the five decades since 1930 (Table 1). In one of his last letters to me, written on February 10th 1977, Roswell Garst, the great pioneer and innovator of American agriculture, who died three years ago, makes the following comments:

"It is my best judgement that the bulk of the increase in the yield of corn between 1930 and 1954 was due to hybridization of corn — and of using only the best land for corn as the acreage went down due to better yields. And some improvements in machinery.

"But the great increase since 1955 has been due to fertilizer, insecticides and herbicides — which lets farmers concentrate the corn on their best acres — and irrigation where water is available — and better drainage where drainage is needed."

And a role was also played by other factors of a non-technological nature, one of which, education, should definitely be mentioned. In less developed countries, where feeding the population is the greatest problem, the majority of people are unable to read or write and the

ratio of teachers to farmers is extremely low. Roswell Garst's home state, Iowa, presents an impressive contrast to this: the money spent on education in the state is more than the value of the maize grown, and this is no doubt one of the reasons why a tenth of the maize produced in the world comes from Iowa (GARST 1980).

Following the American example, the two and a half times increase in Hungarian maize and wheat yield averages over the last quarter of a century has been based primarily on high-yielding plant varieties and the fertilisation needed if the yield potential is to be achieved. The five-year wheat yield averages in Hungary are presented in Table 2, while the main factors responsible for the good two and a half times increase are summarised in Table 3. Though it is true that the secret of successful wheat production is the balancing of production factors, nevertheless, depending on the farming, social and economic conditions, these factors do not contribute to large yields to the same extent, and their significance may also vary from one period to the next.

Far be it from me to suggest that the rapid development achieved in Hungarian wheat production over the last twenty-five years is without precedent in Europe or elsewhere in the world: it is sufficient to mention France, Mexico or China, where wheat yields rose at a similar pace or even more rapidly during this period. But in spite of this, an analysis of the reasons for this development in Hungarian wheat yields may not be lacking in interest for those who are fighting to overcome world hunger and achieve an abundance of food.

2.1. Farm size and efficiency

Not long ago I was asked by the editor of a scientific journal why it was that the peasant agricultures of certain Western European countries achieved higher wheat yields than the large Hungarian farms (RAJKI—PÁL 1979). As an example the editor quoted yields of around 45 q/ha achieved in France and West Germany and the approx. 50 q/ha wheat yield averages in England, which are indeed higher than the approx. 40 q/ha average wheat yield reached in Hungary (all these averages are for a five-year period). With respect to farm size, the average in Great Britain is 64.5 ha, in France 24.1 ha and in West Germany 13.8 ha, while the average size of Hungarian cooperatives is 3500 ha and that of the state farms around 7000 ha. By contrast to my questioner, many people draw quite the opposite conclusion from an analysis of Hungarian wheat yields, finding in favour of large farms. Their argument is based on growth dynamics and they consider the 40 q/ha yield average achieved in Hungary, which represents an increase of more than two and a half times over a quarter of a century, to be more valuable than the world record 50 q/ha yield average achieved in England, which was less than double that obtained 25 years ago. This is quite true, but on these grounds Hungary's large farms must share the honours with France's peasant agriculture, which has also approximately tripled its wheat yields over the last quarter of a century.

Thus, the wheat yields achieved by large-scale or peasant farms do not provide a satisfactory basis for determining optimum farm size. The key to farming efficiency is not farm size, but careful management and the intensity of enlistment in the technological revolution. The personal care which small farmers put into their work and the lack of bureaucracy involved in the farm management are enormous advantages of family farms, particularly in America, provided the size of the farm gives free range to the most intensive utilisation of the benefits of the scientific and technical revolution. But if the size of the farm increases beyond this level, it leads to the farmer becoming estranged from actual farming, and to a decrease in profitability (or efficiency) as the element of personal care fades and bureaucracy gets the upper hand.

With respect to optimum farm size, these comments on efficiency are probably true in general for the agriculture of many developed countries, where a relatively small proportion of the population works on the land. The situation is quite different, however, in the majority of the developing countries, where agriculture is characterised by subsistence farming and large peasant families. The idea that the farming system and technology of highly developed countries can be successfully transferred in their entirety, without any adaptation, to the developing countries, is now largely redundant. In the latter countries small farms, which are more productive than mechanised large farms with respect to yield per unit area, are more likely to be the answer, with labour-intensive, high-yielding "gardening" techniques, such as intercropping (sowing more than one crop in the same field, one variant of which is relay planting, the planting of a second crop between the rows of an earlier ripening crop) and multiple cropping (the sowing of several crops, one after the other, in the same field within a year), the success of which depends in large part on whether the farmer is capable of giving individual attention to every single plant.

2.2. Farming systems to suit the local conditions in the developing countries

One traditionally Chinese "gardening" technique is overplanting or sequential sowing, whereby seeds are sown in seedbeds and are then planted out, often overplanting with seedlings in different stages of development, so that the land is constantly occupied and utilised. With the joint application of irrigation and overplanting the Chinese have grown 10–12 vegetables a year, since time immemorial, on one and the same piece of land. They grow legumes so that nitrogen will accumulate in the soil. Every bit of fertility that comes from the soil is recycled. They save every particle of waste — human waste, composted plant residues, mud from the canals, and even the leaves from the trees on the hills, and return it all to the land. The most frequently grown legume is soybean. The Chinese know many ways of preparing dishes from soybeans to suit their taste. They use bean sprouts to make bean curd, the nearest thing to dairy produce that can be made from plants. Their starch requirement is covered by the rice they grow, and they keep a pig or a few chickens or ducks in the backyard. With such traditional methods a Chinese family of eight is able to produce all the food they need on no more than 2 acres (0.8 ha) and have a balanced diet (KING 1933).

Today approximately 40% of all the irrigated land in the world is to be found in China. A significant proportion of these irrigation facilities have been established during the last thirty years, mostly with manual labour. Simultaneously, the Chinese started to introduce modern techniques and this tendency has been strengthening over the past year or two, as demonstrated by the fertiliser factories which have been built, or are now in the construction or planning stages. China, which stresses the priority of agriculture and the development of industries which serve agriculture, is practically self-supporting with respect to food (BRANDT 1980): the country imports wheat, but exports rice and other foodstuffs, and has a positive trade balance for agricultural goods (imports of 3 thousand million dollars in 1979 as opposed to exports of 4 thousand million dollars). "Visitors to China in recent years almost always comment on the seemingly excellent nutritional condition of the population. Journalists, economists, scientists and doctors all come away with the same impression. The obvious clinical signs of malnutrition, present in almost every other low-income country, appear to be almost wholly absent in China" (BROWN 1975). In the achievement of this self-sufficiency, however, the unique character of the Chinese culture seems to have been more important than any other factor.

So the first step on the road to progress in the developing countries in general may well be a development of the positive elements in traditional techniques, and innovation and modernisation based on the traditional. This is the road which was followed by Japan in the four well-known phases (traditional Japanese farming; the spread of irrigation between 600 and 1850 A.D.; the biological, chemical and mechanical innovations beginning with the Meiji restoration in 1868; and the agrarian reform and complex modernisation following the second world war). The fourth phase, agrarian reform and complex modernisation, which has taken place before our eyes, has resulted in a thriving Japanese agriculture, which has also had a decisive role in the unique development of the whole of the Japanese national economy. In Japan, agriculture was not considered to be of secondary importance, but was regarded as a key element in the development of a new Japanese society (POWER—HOLENSTEIN 1976).

If the work of farming families in the developing countries, who at present aim only at self-sufficiency, is to become more productive and profitable, new high-yielding plant production and animal husbandry systems are required which are well suited to the local soil, climatic, biological and economic conditions. It has been found in numerous countries that farmers, irrespective of their financial state or degree of education, are only too eager, given the chance, to adopt better, more productive, profitable farming techniques. But they can only make a mass contribution to a market economy if a number of conditions are simultaneously fulfilled; namely, if productive, profitable technologies suited to the local conditions are available and the farmers are trained to apply them; further, if the necessary inputs (seed, fertiliser, pesticides, etc.) and purchasing loans are attainable to the farmer; and last but not least, if good local markets are available nearby, where the farmer can sell his extra produce. If any one condition remains unfulfilled, less affluent farmers are automatically excluded from the use of technological innovations, however well they may suit local conditions, and are thus deprived of the extra profit too. In this case the introduction of modern technologies, or of an important new technological element, will in fact increase the inequalities in income which already exist between the farms. The miracle wheat of the green revolution, for instance, is "pretty apolitical" (BORLAUG 1979), and grows well on small and large farms alike . . . always provided, of course, that the economists or politicians do their utmost to ensure that the conditions listed above are fulfilled even on poor farms. If not, the green revolution will be of benefit chiefly to those farmers who can afford the necessary seed,

fertilisers, irrigation and pesticides. But this is hardly the fault of the breeder of miracle wheat.

Right from the start, the apostles of the green revolution drew attention to the fact that the new seed alone is incapable of overcoming starvation, and they repeatedly pointed out that even with a real green revolution, achieved by providing not only the new seed but also the necessary instructions, loans, etc. required to make it a success, mankind would only gain a breathing space of one or two decades to find a way of dealing with the "human population monster" through birth control. Only a government which is really up to the mark will be capable of formulating the necessary policies; of strengthening the scientific and advisory bodies which are of service to farms; of encouraging the activities of marketing, consumer and credit cooperatives prepared to help even the poorest farmers, on the Japanese model; and of carrying out land reforms where this is necessary and possible in order to give the farmer more incentive for production and development, with the proviso that the new landowners can count on cheap credit and other essential aid, without which the immediate result of a land reform would be the temporary disruption of production.

The small number of local researchers at present studying the traditional farming systems in the developing countries and looking for ways of innovating them will need professional and financial aid for a long time to come. It is encouraging that the specialised agencies of the United Nations (FAO, UNU, etc.) and the international agricultural research centres (CIMMYT, IRRI and others), or organisations such as the International Foundation for Science and the International Fund for Agricultural Development, all play an ever increasing role in training third world researchers and in sponsoring local research and development projects. Thus, a number of international agricultural research centres now spend up to 20–30% of their budgets on research into farming systems, which was not the case even five years ago. During the last three years the International Fund for Agricultural Development has spent approximately a thousand million dollars on projects aimed at developing the food production and consumption of the poorest people in the poorest countries (BRANDT 1980).

3. Other ways — beyond an increase in yield average — to develop food production

Apart from the raising of yield averages, which has been considered up to now, another way of increasing food production is the expansion of the cultivated area. I have recently witnessed two impressive examples of the cultivation of barren land, one in March 1979 in the USA, in the southwest corner of Kansas, where twenty years ago the March wind sent bundles of bone-dry weeds rolling across the sand-dunes by the banks of the Arkansas river. But an enterprising farmer drilled the sand for water and found he did not have to drill very deep. After levelling off the sand and setting up irrigation equipment he planted the land with maize and the richly fertilised and irrigated sand paid well right from the first year: in a well established crop it proved virtually impossible to grow less than 150 bu/acre maize grain. Meanwhile, the farmer doubled his sand empire year by year, until it now measures 10×10 miles = 100 square miles and a comparison with the sand, which has been left in its original state in some places, furnishes a more speaking proof of man's creative ability than any words can convey. I saw the second example in May 1977, on the Nabatean Desert Farm in Ovdad, Israel, where research is carried out on collecting and utilising the annual 80 mm rain falling on the Negev desert for irrigational purposes. They draw on thousands of years of experience in irrigating the desert by collecting water, and in fact make use of the remains of a system built for a similar purpose in the neighbourhood of the farm thousands of years ago. An area 20–25 times as big as the area to be irrigated is required if enough water is to be collected for the irrigation. The slope and size of the canals must be scientifically determined, not only to ensure that the irrigated area is adequately supplied with water, but also to give protection from the torrent of water which rushes along the canals after a sudden downpour. In the very middle of the scorching desert stands a plantation of almond and pistachia trees weighed down with fruit: the sight of such creativity is enough to make you believe in the future of the human race! Similar plantations on a farm scale are just being set up in a few places in the surrounding desert.

Of course, the expansion of the cultivated area is becoming increasingly difficult and expensive, and lack of water seems to be the greatest obstacle, but the rise in the price of fertilisers as energy prices rise is also becoming more and more of a problem.

The third possibility of developing food production which I should like to mention is the use of the whole cereal plant as ruminant fodder; i.e. not just the grain but the stalk and leaves, and for maize the cobs too. After twenty years of experimentation. Roswell Garst,

whom I mentioned above, established the fact that maize waste (stalk and cobs) contained one third of the feed value of the maize yield, i.e. of the whole plant, and that, properly complemented with a little grain maize and with carbamide, mineral salts and vitamin A, it was an excellent, cheap cattle feed. Nowadays, as a protein substitute, carbamide and other non-protein nitrogen sources make up more than 10% of the total "protein" fed to livestock in the USA. Carbamide probably represents over half of all the protein supplements fed to cattle. Ruminants, which, due to the bacterial flora of their compound stomachs, are able to digest plant waste (cellulose) in much higher proportions and to make use of the traditional fodders (meadows and pastures), have much more future in the long run than pigs and chickens, whose simple stomachs require feed mixes based on grain and which utilise the grain very inefficiently. Obviously this does not apply to pigs and chickens which are kept in the backyard, whether the yard is situated in the developing countries or elsewhere.

It is worth including here a statement by a member of the British Farm and Food Society, which is still dismissed with a wave of the hand by the vast majority of people: "... the conversion of protein into animal flesh for human consumption is extremely wasteful, and has no future in a hungry world except where livestock can be reared on areas unsuitable for crop production ... what we need from nutritionists are suggestions for an alternative diet in which vegetables, grains, pulses and nuts are used imaginatively to satisfy our alimentary needs and please our palates" (BOWER 1975). It is generally acknowledged that the function of livestock in food production is to concentrate protein. This consists of the combustion of carbohydrates in order to produce energy and the building of concentrated high-quality protein from part of the plant protein in the feed. But the efficiency of even the most effective conversion of plant into animal protein is extremely low. Under modern conditions chickens are relatively the most efficient converters of plant into animal protein, in the form of eggs or meat. Even so, hens only convert 30% of the feed protein into egg protein. For broilers this conversion efficiency is hardly more than 20%, and even less for other livestock. Naturally this is not a matter for concern in the case of plant waste which cannot be used directly for human consumption, or on land which is only suitable for haymaking or pasturing. But it certainly becomes a problem when it is a question of plants which can also be consumed directly by man, or of land where plants suitable for direct human consumption can be successfully grown.

Not a great deal of interest is shown in the problem of overconsumption and its negative consequences either. Without going into detail, partly because I am not an expert on the subject, the symptoms of over- and under-nourishment are similar in many respects: a reduction in health and working ability, more susceptibility to diseases and a lower life expectancy. And overconsumption is associated, mainly indirectly, with a waste of grain, particularly in societies and social strata which are financially better-off.

One way of saving energy is to use minimum tillage, whereby special attachments, singly or in series, carry out one or two necessary operations at the same time as sowing, but without ploughing. This is quite something, because from time immemorial farmers have turned the earth with a plough so that they could cultivate and plant it. The generations of farmers who come after us are hardly likely to understand why their predecessors thought it was necessary to turn and mix the soil every year and then to compact or rake it, when these are all such costly and labour-intensive processes. The simplest and perhaps most highly perfected of the minimum tillage attachments is the Acra-Plant Opener, which cuts a V-shaped slice in unploughed soil and simultaneously places the seed in a compact seedbed, as moist as the circumstances allow, at equal spacing and depth. In a sense this is going back to the pointed sticks used by prehistoric man. The sowing of maize without ploughing is facilitated by cattle husbandry based on the waste products of maize growing (suitably supplemented stubble grazing and stalk silage), because as a result of stubble grazing and the silaging of the remaining stalks, there is no need for the energy-intensive ploughing under of stubble remnants.

4. Science in the service of technological progress

As far as research is concerned, without wishing to detract from the value of the support given to the vital farming systems research in the developing countries, or from the fundamental importance in plant production development of improving the efficiency of photosynthetic activity, biological nitrogen fixation, fertilisation and minimum tillage, the emphasis in plant research in the developed countries should in the future continue to be on genetic development. This means the breeding of plant varieties which make more efficient use of their environment. Let us take wheat as our example again and consider the prospects of wheat breeding at Martonvásár.

In wheat research at Martonvásár the aim is to produce a short-strawed (75–80 cm) type of wheat with large ears, high quality and excellent climatic and disease resistance, capable of giving a stable grain yield of 80–100 q/ha under Hungarian farm conditions. To set this aim and hope to achieve it in the foreseeable future is only realistic with the help of the phytotron, which enables the breeding time to be shortened, the breeding stock, particularly the number of new combinations available for selection, to be increased many times, and the frost resistance of the varieties and lines to be objectively tested. But first of all a phytotron had to be built, and then we had to learn to work in it and adapt wheat breeding methods to suit the phytotron (RAJKI 1978, RAJKI—PÁL 1979).

Looking back over the last few decades it is now possible to identify the scientific and technological achievements which led to rapid increases in world food production: the hybridisation of maize from the thirties onwards, the rapid spread of fertilisation in the developed countries after the second world war, and recently the miracle wheat and rice varieties of the green revolution in certain developing countries. And however depressing it may sound, I really must agree with the statement, that at present there is no sign whatsoever in the research laboratories and nurseries of any new technological achievements to compare with these in efficiency (BROWN 1975).

5. Starvation and its twin, poverty, and the prospects for overcoming them

Although it only reflects the buying power of nations and individuals, for lack of anything better the foreign trade balance for grain must be accepted as the basic measure of food sufficiency (KIMMEL 1980). Prior to the second world war all the geographic regions except for Western Europe were net exporters of grain and North America was not a leading exporter. Between 1934 and 1938, for instance, South America exported an average of 9 million tons of grain a year compared to 5 million tons for North America, while a similar amount was exported by the Soviet Union. In the meantime the situation has changed out of all recognition: a good two-thirds of the approx. 200 million tons of grain exported annually comes from North America, chiefly from the USA, while the remainder is shared almost exclusively by Australia and Argentina. The Soviet Union, which was traditionally a net exporter, has become the biggest importer of grain, with joint imports for the Soviet Union and the other European planned economy countries reaching an annual 50 million tons. But the grain imports of the developing countries also show a rapid increase: without counting the significant grain imports required in bad years by India, which in good years satisfies the market demand domestically as the result of the green revolution, these imports are now in the region of 80 million tons a year and are likely to reach 100 million tons within a year or two. It should be noted that transformations in foreign trade patterns for grain can be attributed to regional or country by country variations in the population growth rate and increases in production.

The general aim for the future cannot be other than regional self-sufficiency in grain production, particularly in the developing countries. Provided the necessary economical, social and educational conditions are satisfied, the total amount of grain produced in the world is already more than enough to satisfy mankind's food requirements with high quality foodstuffs, and, provided birth control measures keep the population growth rate at a reasonable level, our present knowledge and technology will be capable of supplying a satisfactory quantity and quality of food to meet the growing demand for a long time to come, so there is really no need for hunger. Nevertheless, today hunger is still a very urgent problem, which mainly afflicts poor countries and the poorest sections of the population all over the world. Hunger and poverty go hand in hand in agricultural and urban areas alike. Starving people have no money to buy food, so the suppression of hunger is inseparable from prosperity. But what are the prospects for prosperity in a world where, according to the latest estimates by the United Nations Foundation for Population Activities, the number of unemployed is likely to increase from the present 300 million to a thousand million by the turn of the century?

The problem is a complex one, because the first step towards prosperity for the starving millions in the developing countries, for instance, means avoiding death by starvation. In the true sense of the word there is no "general" prosperity for the whole of society in the most highly developed market economy countries either, because the low buying power of certain population groups compared to others limits their ability to meet requirements which could in fact be satisfied. So prosperity is not general even in these societies, but is differentiated from one population group to the other. But despite this, and despite the fact that unemployment will continue to rise as the mechanisation and automation of simple work processes proceeds at an ever greater rate, the prospects for an increase in general prosperity by the turn of the century are still brighter in the most highly developed market economy countries

than anywhere else. Their situation is also eased by the paradox that more food means less babies, which is a strictly human phenomenon: animals and plants respond to an increase in nutrients with a larger number of progeny.

The societies struggling to overcome starvation in the developing countries are afflicted with the opposite of this paradox: they suffer not only from lack of food but also from the associated population explosion. On occasion North America can provide food from its burdensome surplus or from other sources in the form of food relief programmes to keep starvation at bay or to feed the hungry, but this alone is obviously not a solution which holds out any hope. At the same time it would be difficult to find a "starving country" which looked likely to be able to help itself within the foreseeable future with or without external technical aid or a green revolution. Yet the primary interest of any national government, if it wishes to stay in power, is to satisfy the basic needs of its citizens. These include a sufficient food supply, freedom and security for the individual and the nation and a steadily improving standard of living (WORTMAN—CUMMINGS 1980).

The area of the world in which we Hungarians live is again a special case. Here, after achieving promising results under the influence of the initial impetus, the socio-economic limits to the development and utilisation of science and technology are becoming more and more apparent. Of these, mention should first be made of the theory and practice of neglecting or even restricting the development of the stronger and better and of concentrating solely on helping the weaker to catch up, and secondly of the fact that the efficiency level of the financial incentives and the degree of self-determination lag behind those offered by private ownership. These factors, together with the social depreciation of agriculture, are the fundamental reasons for the chronic shortage of food which has developed in this area of the world.

It is misleading to question the right for dissent, i.e. the right to hold an opinion different from the official view imposed from above, without having to fear any kind of discrimination, and to treat this as the privilege of the cultured elite (BORLAUG—ANDERSON—SPRAGUE 1980). The consciousness of the vast majority is indeed determined more or less by mass media and only a minority is capable or willing to critically examine the information issued by the mass media and to sieve and evaluate it. But this thinking minority is recruited from practically all ranks of society. In other words, it includes not only writers and artists, scientists and teachers, engineers and physicians, but also peasants, labourers and others. Their number would be far greater if the emphasis in education, both in the schools and elsewhere, were not on the cramming of ready-made knowledge, but on the development of the ability to think, and if minority, not to mention heretical, views were allowed to co-exist peacefully with the official views. There is and can be no creative science without the freedom to express and defend minority opinions. "The frequent shrinking back from pioneering, path-finding actions . . . induces one of the most serious economic problems: a low degree of efficiency" (NYERS—MEZEI 1980).

5.1. The social depreciation of agriculture

But what effect does the social depreciation of agriculture have in a country like Hungary, which has achieved noteworthy results in food production over the last fifteen years and has not only become self-supporting with respect to food but also exports approximately a quarter of its total agricultural produce? Under the old social system the peasant was held in contempt, and the (heavy) industry-centred viewpoint of the last three decades has enriched this with new features. Thus, it will be impossible to eliminate the remnants of the century-long tradition of despising peasants without also getting rid of the new prejudices which have developed more recently.

The respect afforded to agriculture and peasants by those in power ebbs and flows, depending on the food situation, and in fact on the situation in general. During critical periods, the development of agriculture is always given priority, as it was in Hungary in 1956 and at present in Poland. But would it not be better to grant continuous priority to agricultural development in order to prevent crises from occurring at all?

This reminds me of a conversation I had thirty years ago with a Hungarian professor of mathematics, for whom I have always had a great respect. This conversation began with his asking me whether such a thing as agricultural sciences actually existed . . .

Of course, in my case too, the recognition of the primary importance of food was not a congenital part of my thinking. In the second half of the fifties, during one of my first trips to America, at the time when a dog named Laika was rocketed into space from the steppes of Central Asia, an American friend of mine remarked in the course of conversation that the food produced by American agriculture was a stronger weapon than any rocket. At the time I did not follow this train of thought. A few years later, when I was working at Minnesota

University, my old friend Roswell Garst invited me to spend Christmas on his farm in Coon Rapids, Iowa. On that occasion Roswell presented me with a copy of his brother's newly published book, "No need for hunger" (GARST 1963). Reading this book opened my eyes and in a certain sense helped me to identify.

If the contempt still felt for peasants and for agriculture in general is to be stamped out once and for all a change of attitude will be required, in two senses. First, a repudiation of the false belief that the importance of agriculture can be measured in terms of its contribution, usually calculated at parity prices, to the gross national product; and secondly, a recognition of the fact that the development of agriculture, the food industry and the industries which serve agriculture, above all the agricultural machinery and chemical industries, is of primary importance, as is the development of agricultural and other relevant sciences, and that these should be given top priority. Because for any human activity whatsoever the most important thing is to keep ourselves alive, and first and foremost this requires food.

Hungary's poverty in energy and industrial raw materials only serves to underline the rationality of giving priority to this complex development of agriculture, since directly or indirectly the raw materials of food are carbon dioxide and nitrogen from the air, mineral salts from the soil, and water from precipitation and the ground, while the energy is provided by sunshine. All of these are available plentifully, cost-free and in excellent quality in Hungary. And perhaps there is also no lack of another renewable source of energy which is essential for success: sound commonsense and inventiveness.

Unfortunately, in the course of my travels in many parts of the world, I have so far met with a situation more or less the same as that in Hungary with respect to the depreciation of peasants and agriculture.

6. On the quality of human life

Of course, certain positive phenomena are also to be found in the world. The migration away from the smoke and noise of the concrete jungle is most pronounced in the most prosperous and urbanised societies. As a dwelling-place the sky-scraper is an anachronism. This attempt to go "back to nature" is becoming more and more general and in time it will no doubt conquer the whole of mankind. The family house with a garden, and of course with all modern conveniences, including hot and cold running water, a refrigerator, and air conditioning where necessary, has always been and always will be the height of our dreams. There is also a welcome increase in the number of garden and animal lovers. Already the demand for land suitable for allotments exceeds the amount of land available. Steps should be taken to provide the necessary conditions before it is too late, since the possibilities offered by gardening are almost unlimited. The demand for freshly picked, ripe, red tomatoes, early peppers and other fresh vegetables is already great all the year round, independent of the season, and is increasing by leaps and bounds. What is needed is the establishment everywhere of large numbers of mini-greenhouses and polythene frames or tents. And this does not only apply to really fresh vegetables; the only way for freshly picked, ripe apricots and greengages and fragrant strawberries to reach the family table directly and unharmed is from small private gardens.

And what about the leisure time which is required for a hobby? A decade or two ago the 48-hour week was the battle cry of the workers, whereas recently the German steelworkers in Westphalia were striking for a 35-hour week. This is a move in the right direction.

And the lack of respect for peasants? When I was in Garden City, Kansas, in March 1979 I saw the same badges on the farmers' chests as my son, a mathematics student, brought home one summer after a trip to America: "I'm proud to be a farmer". The greatest admiration and respect is also due to those Norwegian farmers who, at the beginning of the seventies, when plans were made by top bureaucrats for Norway to enter the European Economic Community, protested and insisted that for them farming was not just a means of sustenance but a way of life, where they were their own bosses. They stuck to their right for self-determination and refused to have "happiness" forced upon them against their will.

But what if money or credit is needed to invalidate the prophecy made nearly two hundred years ago by Malthus? Instead of interminable speeches aimed at deluding the public into thinking that they are peacefully inclined, the governments should follow the example set by Costa Rica, where they had the courage to demobilise the army and have consequently spent nothing at all on armaments for a considerable length of time! At present the restrictedly unrestricted arms race costs mankind an estimated one to one and a half thousand million dollars a day, and this burden is increasing perceptibly every year. In this arms race the maintenance of the alleged balance of power weighs more or less heavily on the

opposing parties, depending on their economic potential. Mankind will wait in vain for an escape from this vicious circle on the basis of the old Scottish proverb "A wise man wavers . . .", or for any other reason dictated by commonsense. Governments and others in positions of power should not forget that authority was made for man and not vice versa, and that the end does not justify the means!

In the middle of the last century, when Darwin removed the cloak of obscurity from the past history of the living world and enriched mankind with the glorious panorama of evolution, he put man's claim to be the crowning glory of creation on a scientific basis and established his place in nature's hierarchy. But a distortion of civilisation has wrenched man away from mother nature and has deprived him in great part of his powers of contemplation. He will only succeed in finding himself if the original organic ties with the natural environment are reformed. Grass, trees and flowers, silence, solitude and the starry sky are just as necessary for the perfection of human nature as food is for the maintenance of life. Human dignity and the real human values — humanity, freedom and truth — must not become the victims of over-zealous organisation, supervision and automation, nor must the blessings of nature be destroyed by depredation and environmental pollution!

There is a need for a fundamental change in our traditional scale of values and our views on life, combined with a new moral code and a re-think on our relationship to nature, because the great promise of industrial civilisation to overcome nature and bring financial plenty, giving the majority of mankind the maximum chance of true happiness and unconstrained freedom, has not yet materialised, nor is it likely to (FROMM 1976).

In parting, allow me to recapture a thought which kept running through my mind in June 1978, on the way home from a combined professional and cultural excursion on the last day of the Food and Nutrition Workshop at Martonvásár and which I included in a toast at the closing banquet: "We must not allow the wings of those who are capable of flying higher than the rest to be clipped, because the future of humanity depends on those wings".

S. RAJKI

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EFFECT OF RAISING CONDITIONS ON PROLIFICACY IN EWES*

It is a generally accepted view that as a result of domestication the times of sexual maturity and breeding maturity have become separated in respect of age and development stage alike.

As a contrast to the almost classical view, in experiments with cattle REID *et al.* (1964) and AMIR *et al.* (1967) obtained results which made the revision of the earlier views necessary. In cattle species the prolificacy of Holstein heifers raised at a medium energy level and made pregnant a few months after the onset of sexual maturity showed a more favourable trend, and the method also proved much more economical.

In sheep, a species capable of much quicker development, the first lambing takes place at the age of 24 months all over the world, in spite of the fact that sexual maturity appears relatively early, at the age of 150–240 days. This long period between the appearance of sexual maturity and the beginning of breeding can definitely not be regarded as natural.

In a lecture in which he referred to an earlier publication by LAND *et al.* (1973), THIMONIER (1975) reported the date of birth and date of first heat for 98 ewe lambs of different breeds and crosses. The date of birth ranged from 1st January to 6th June, giving differences of 156 days.

The first oestrus was observed between 30th August and 2nd November, i.e. the time interval was reduced to 94 days. Thus, in addition to the age and development stage of the animals the role played in the appearance of the first heat by stimulation exercised by shortening days on the ovary cannot be left out of consideration.

In Romanov lambs born in spring on the experimental ground of the Agricultural College, Kaposvár, the first oestrus is again observed at the age of 5–6 months, although ROBINSON (1978) also found that in fertile breeds belonging to types with vigorous metabolism sexual maturity was expected to set in at the age of 3–4 months. Of the 16 Romanov and Finnish × Romanov ewe lambs kept for breeding in August and September 1976, 7–44% had the first oestrus between 17th December 1976 and 27th January 1977 at an average age of 130 days (minimum 109, maximum 142) and with an average weight of 21.9 kg (VERESS *et al.* 1979). According to ROBINSON (1978), in the ewe lambs of fertile breeds the first oestrus may occur any time after 3 months of age.

In another experiment (VERESS *et al.* 1976) 20 ewe lambs born in July 1973 from F₁ ewes derived by crossing fertile breeds (Finnish, Friesian, Romanov) with a Romanov ram were fed ad libitum alongside 2 young rams of the same age up to the age of 150 days. Then the young rams were slaughtered and the ewe lambs continued to feed ad libitum. Three of them died of enterotoxemia, while 13 lambed (76%) at an average age of 282 days giving a 177% rate of reproduction. The average birth weight of their progeny was 1.82 kg, and 52% died before 28 days of age. The live weight of ewes which lambed early reached that of those lambing later by the age of 2 years, but as regards the intervals between lambings and the rate of reproduction they did not reach the expected level. Of the four ewes which lambed later only one (25%) showed acceptable prolificacy. By analogy with the heifer raising experiments referred to above, the explanation for this seems to be the high energy level of feeding. The milk production of ewe lambs which are used for breeding early is very low, therefore the loss involved in the artificial raising of their lambs would presumably have been less.

In 1933 GAÁL (1957) raised more than 200 merino ewe lambs of Hungarian-Rambouillet type so that the bulk of the stock (90%) lambed by the age of one year. They were not underdeveloped when fully grown and their milking capacity was better than those which lambed at the age of two years.

These findings were supported by exact experiments carried out by MASON—DASSAT (1954) with Sardinian and by MEREU (1957) with Langhe breeds. Thus the over-long interval between the appearance of sexual maturity and the beginning of breeding is not favourable for milk production in ewes.

Under good feeding conditions attempts were made to induce lambing in every Romanov ewe-lamb born and raised (VERESS *et al.* 1979). The rate of reproduction and the net lamb production for ewes lambing for the first time at the age of 22 months or later were lower than average (Table 1), which also seems to prove the theories and observations made earlier.

In spring 1977, 1000 breeding ewe-lambs, weaned at the age of 40–50 days, were raised until 90–100 days of age so as to attain an average daily weight gain of 200–240 g, i.e. not less than that attained during suckling. The daily fodder consumption was then limited

* Presented at the 30th Annual Meeting of the European Association for Animal Production, 22–26th July 1979.

to 0.5 kg, and the animals were put to pasture on a solonetz type soil replanted after subsoil loosening and liming. By providing daily sections using an electrical fence it was possible to feed the maximum amount of grass, so the fodder ration was further reduced to 0.25 kg a day. After their rate of growth had slowed down, which was promoted by their moving steadily while grazing in addition to the reduced energy level, the ewe lambs reached 65% of the live weight of fully grown ewes by the age of 8–9 months, with an average daily weight gain of 106–113 g. As a result of mating, 65.7% of the animals conceived.

Thus, Merino-Rambouillet ewe lambs, which were previously thought to mature medium late, lambed at the age of 13–14 months and raised an average of 0.469 weaned lambs. In comparison to those lambing traditionally, at the age of two years, the cost of raising them was substantially reduced (by 40–50%), if the number of lambs is also taken into consideration.

Table 1

Some major indices of the combing Merino ewe lambs studied

	First flock		Second flock	
Date of birth of ewe lambs	January 1977		February 1977	
Number put out to pasture	450		550	
Date of putting out to pasture	29. 4. 1977		18. 6. 1977	
Live weight when put out to pasture, kg	$\bar{x} = 27.33$		$\bar{x} = 27.18$	
Beginning of mating	10. 10. 1977		1. 11. 1977	
Average weight at the beginning of mating, kg	$\bar{x} = 42.43$		$\bar{x} = 41.57$	
Average daily weight gain while grazing until the beginning of breeding, g	$\bar{x} = 113.5$		$\bar{x} = 106.6$	
	n	%	n	%
Culled before breeding	25	5.55	30	5.45
Oestruated within 42 days	320	72.00	408	78.40
Conceived	280	65.80	341	65.60
Abortions proved	45	16.00	60	17.50
Lambs born/progeny rate	235	100.00	281	100.00
Loss up to weaning	36	15.30	28	10.00
Useful increment	199	84.70	253	90.00

Table 2

Age on first lambing and progeny of Merino ewe lambs raised and kept in the same flock

Age on first lambing, days	340–420	421–480	540–730	731 <	total or \bar{x}
Number of animals, n	158	111	109	38	416
Average age (days), \bar{x}	393.1	441.1	609.4	940.9	—
Proportion, %	38.0	26.7	26.2	9.1	100.0
Progeny rate, %	103.2	100.9	109.2	107.9	104.6
Raising rate, %	93.9	96.4	97.5	100.0	96.1

In an earlier experiment 416 ewe lambs, again of Hungarian Merino breed and born in spring 1973, were raised in such a way that 38% of the stock lambed at the age of one year and 27% at 16 months old (Table 2). The whole stock was kept in one flock and lambed frequently. Their later progenies were also followed with attention (Tables 3, 4).

Ewes lambing for the first time at the age of 16 months or earlier produced an average of 4.22 lambs in 3.86 lambings during the 43 months of the observation period. Ewes lambing for the first time at the age of 18 months or later produced only 3.46 lambs in 3.08 lambings in the same period. No significant difference was observed in the frequency of lambing between the two groups. 38.28% of the animals which started lambing earlier, but only 30.6% of those put to breeding later had to be culled during the period of observation. Early breeding was thus found to increase the deterioration of the ewes, although the ratio of progeny to the number of lambings was the same.

The practice of frequent lambing is gradually becoming wide-spread in Hungary. In spite of this, even stock breeders prefer to use lambs born in spring for breeding. Thus, an answer was sought to the question of whether the adult productivity of ewe lambs born in different seasons shows any difference. In 1971/72 a comparison was made of the average date of first conception for Merino ewe lambs in a stock born in different seasons and kept for breeding purposes (Table 5). Compared to ewe lambs born in the traditional spring lambing period, those born in summer conceived 2 months earlier, and lambs born in autumn and early winter 3 months earlier. A very high individual variation was observed within the groups, and the difference between the groups proved to be statistically significant. At the second pregnancy the variation within the groups decreased, while the difference in age between the groups further increased. Ewe lambs born in summer became pregnant 2 months earlier, and those born in autumn 4 months earlier than the stock born in spring. The statistically calculated result again gave significant differences.

Where the grass yield of the pasture is abundant and is not infested by endoparasites, it is worth putting breeding ewe lambs of 20–25 kg weight out to pasture and fixing their

Table 3

Progeny of Merino ewes raised and kept in the same flock
(Between March 1974 and October 1977)

Indices	Age on first lambing						
	below 16 months of age						
	number of lambings						
	I	II	III	IV	V	VI	total
Number of lambings, n	269	257	224	174	92	23	1039
Proportion of lambings to the initial stock, %	100	96.3	83.9	65.2	34.5	8.6	—
Progeny rate, %	102.2	108.2	118.8	126.4	130.4	139.1	114.7
Raising rate, %	94.9	96.4	97.7	97.3	90.8	84.4	95.5
Indices	Age on first lambing						
	above 18 months of age						
	number of lambings						
	I	II	III	IV	V	VI	total
Number of lambings, n	147	127	100	60	19	—	453
Proportion of lambings to the initial stock, %	100	86.4	68.0	40.8	12.9	—	—
Progeny rate, %	108.8	118.1	119.0	118.3	131.6	—	115.9
Raising rate, %	98.1	96.0	96.6	94.4	84.0	—	96.0

Table 4

Intervals between lambings as a function of age at first lambing in Hungarian Merino ewes

Interval between lambings, days	Animals lambing for the first time				Total	
	between 340 and 480 days of age		when older than 18 months			
	n	%	n	%	n	%
<240	236	42.3	86	33.0	322	39.3
241—270	142	25.4	72	27.6	214	26.1
271—365	39	7.0	39	14.9	78	9.5
366—548	116	20.8	53	20.3	169	20.6
548<	26	4.5	11	4.2	37	4.5
Total:	559	100.0	261	100.0	820	100.0

Table 5

Age of ewes on first and second conception (months)

	Time of birth	n	\bar{x}	$\pm s$	v%
Age at first conception	February, March, April, July,	243	16.69	2.88	17.24
	July, August, September	148	14.61	4.76	32.60 F = 20.35
	October, November, December	263	13.86	6.60	47.64 P = 0.1%
Age at second conception	February, March, April	52	26.33	1.60	6.10
	July, August, September	60	24.08	5.14	21.37 F = 11.69
	October, November, December	151	22.38	5.92	26.46 P = 0.1%

daily rations by means of an electrical fence. Animals kept under such grazing conditions, with a sufficient quantity and quality of grass, need not be given supplementary fodder. Care must be taken, however, to ensure that the monthly weight gain reaches 3—3.5 kg per animal. This requires a daily grass ration equivalent to 1—1.5 kg dry matter.

Ewe lambs should be raised so that they reach sexual maturity at the age of 200—240 days; 30—60 days later, if their weight reaches 60% of the live weight when fully developed, breeding can begin (ROBINSON 1978). According to MAIJALA—OESTERBERG (1976) this is an established practice with the Finnish breed and similar attempts are being made with other Western European breeds too.

Frequent lambing was not adversely affected by beginning breeding earlier, but the ewes deteriorated more quickly, in proportion to the increased number of lambings.

The theory (VERESS 1973) that ewe lambs born outside the main lambing season are worth keeping for breeding purposes seems to have proved right. The conditions for raising lambs born in summer and autumn are more favourable in Hungary.

Since in the Merino and Romanov breeds considerable differences in the date of sexual maturity and breeding maturity have been experienced, attention is drawn to the necessity of paying increased attention to sexual prematurity in the course of selection.

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THE EFFECT OF FRESH AIR ON THE CO₂ LEVEL OF PHYTOTRON UNITS*

In the majority of plant growth cabinets and chambers now in use the CO₂ level is regulated by introducing fresh air. The greatest disadvantage of this method is that there is no feedback to indicate the actual CO₂ level, so this cannot really be considered as regulation. Some authors (DOWNS—HELLMERS 1975) consider the majority of make-up air systems to be quite useless and feel that they lead many researchers to the false conclusion that there is no CO₂ stress in the chambers. Calculations carried out in the Canberra phytotron (MORSE 1963) show that if a 10% drop in the CO₂ level is allowed, 1.53 m³ fresh air is necessary per minute for each square metre of growing space (approx. 90 m³ · h⁻¹ · m⁻²). This is equivalent to an air exchange rate of 50 times an hour for a phytotron unit with a ceiling height of 1.8 m.

It is characteristic of make-up air systems that the CO₂ concentration in dark periods is always greater, and that in illuminated periods is always less than the ambient CO₂ level. The difference depends basically on the air exchange rate. TIBBITTS—KRIZEK (1978) measured the extent of fluctuation and calculated the equilibrium CO₂ for a given case. Naturally, a large number of other factors (e.g. the developmental phase of the experimental plants, stand density, temperature, light, etc.) also have a modifying effect. In addition to modifying factors, disturbing factors should also be mentioned, the most general and frequent of which is the CO₂ introduced into the growing areas by humans carrying out programming treatment, scoring, etc.

According to MORSE's (1963) calculations, mentioned above, an air exchange rate of 50—90 times per hour, depending on the height of the growing area, is necessary, if a 10% reduction in concentration is allowed. This means that 50—90 times as much air must be climatized as in a completely closed system, and owing to the lack of regulation this is ener-

* Lecture held at the Symposium on "Anwendung und Ergebnisse der Phytotronik in der physiologischen und Züchtungsforschung" November 9th—13th, 1981, Eberswalde, GDR.

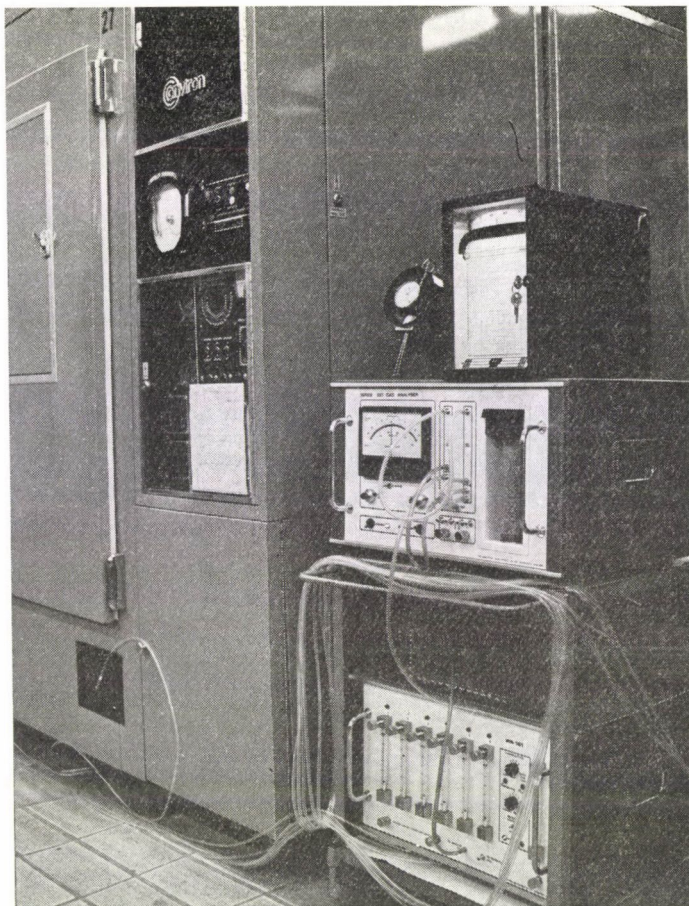


Fig. 1. The E-15 Plant Growth Cabinet and 225 MA Infrared Gas Analyser

getically uneconomical. Due to the high cost of gas analysers, and thus of CO_2 regulating systems, a radical change in this situation cannot be expected. It is thus essential to take a closer look at the effect of modifying factors in order to obtain sufficient information to determine the minimum air exchange rate required in any individual case.

The data given below, based on measurements made in the phytotron at the Agricultural Research Institute of the Hungarian Academy of Sciences, Martonvásár, may help to clarify this problem. The measurements were carried out in a Conviron (Canada) E-15 Plant Growth Cabinet, using a 225 MA Infrared Gas Analyser and a 161 Gas Handling System (Fig. 1) manufactured by the Analytical Development Co. Ltd. (England).

First the transient phenomena were measured. The number of plants in the phytotron unit was 60 per m^2 . The experimental material consisted of rye plants at the beginning of heading. The temperature in the plant growth unit was 23°C , the relative humidity 70% and the photosynthetic photon flux density (PPFD) $500 \mu\text{E} \cdot \text{m}^{-2} \cdot \text{s}^{-1}$ (illumination 28 klx). The illumination was provided by a 6 : 1 mixture of Gro-Lux/WS fluorescent tubes and incandescent lamps. At the start of the experiment, with an air exchange rate of 12 times an hour without illumination, the CO_2 level was $0.5 \text{ mmol} \cdot \text{m}^{-3}$ higher in the phytotron unit than the ambient CO_2 level. When the illumination was switched on, the CO_2 level fell $1 \text{ mmol} \cdot \text{m}^{-3}$ below the ambient level within 10 minutes, then 20 mins after switching on it reached a stationary state $1.5 \text{ mmol} \cdot \text{m}^{-3}$ (10%) below the ambient level (Fig. 2). If the

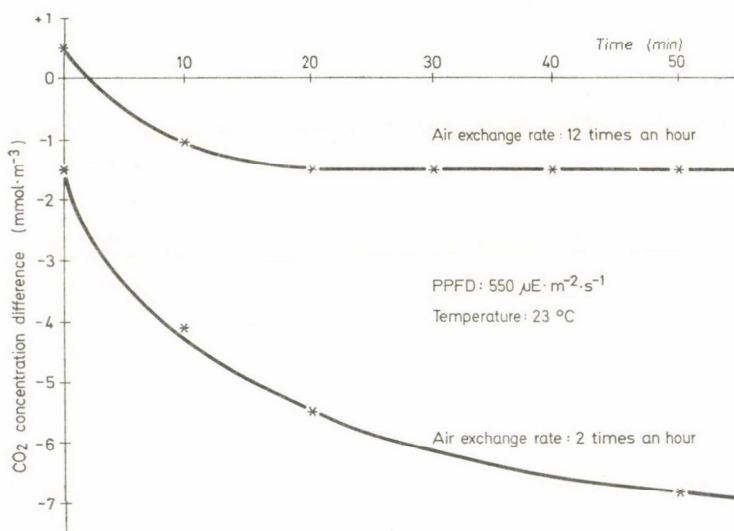


Fig. 2. Effect of light and reduction of exchange rate on the CO₂ level

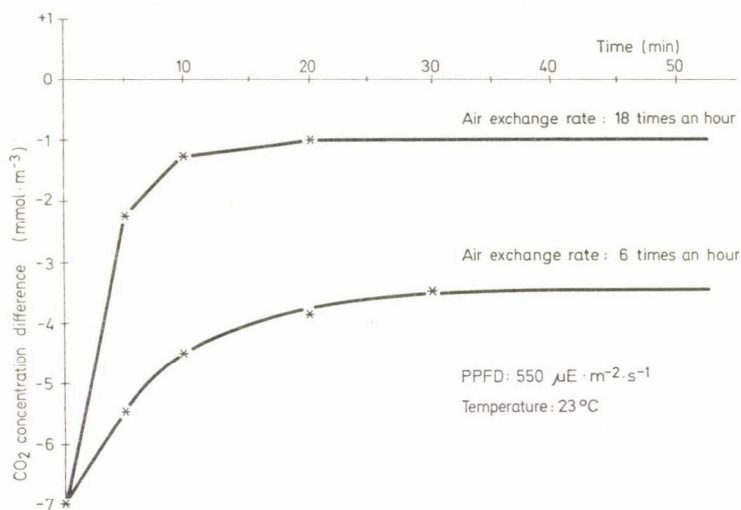


Fig. 3. Effect of increase of exchange rate on the CO₂ level

air exchange rate is reduced from 12 times to 2 times an hour the CO₂ level drops rapidly: after 10 mins it is 4 mmol · m⁻³ below the ambient level; after a further 10 mins this figure is 5.5 mmol · m⁻³, while an hour after the reduction the CO₂ level is 7 mmol · m⁻³ below the ambient level (Fig. 2).

By increasing the air exchange rate from 2 to 6 times an hour a stationary state is reached at a difference of 3.5 mmol · m⁻³ within 30 mins (Fig. 3). If the rate is increased from 2 to 18 times an hour it takes only 20 mins to reach a stationary state at 1 mmol · m⁻³ below ambient level (Fig. 3).

Thus the transitions take place relatively rapidly, so examinations should be concentrated primarily on the stationary states. The measurements were continued, again on

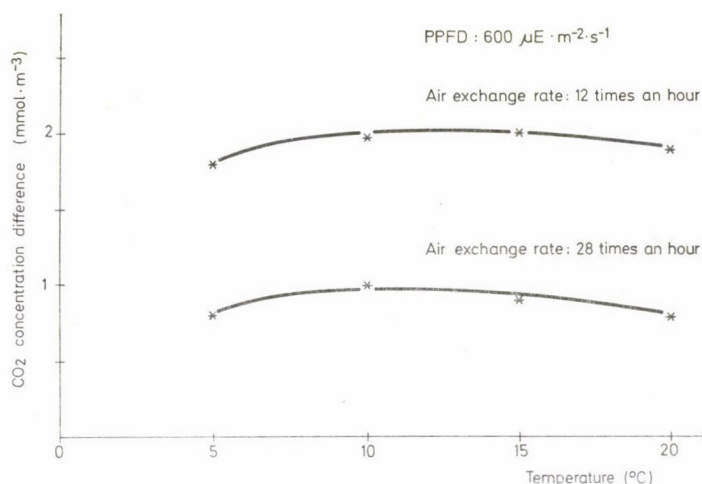


Fig. 4. CO₂ concentration differences at four different temperatures and two air exchange rates (illumination 40 klx)

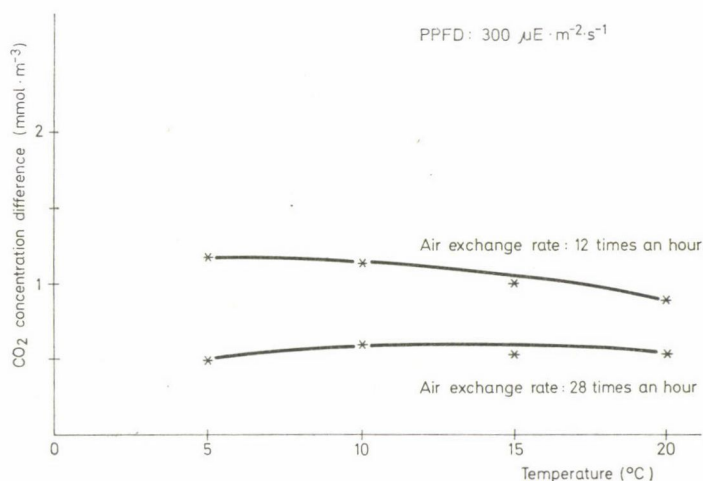


Fig. 5. CO₂ concentration differences at four different temperatures and two air exchange rates (illumination 20 klx)

rye plants before heading at a stand density of 60 plants per m². At four different temperatures (5, 10, 15 and 20°C) combined with 2 radiation intensities and two air exchange rates the CO₂ concentration differences shown in Figs 4 and 5 were obtained. The PPFD values were 600 $\mu\text{E} \cdot \text{m}^{-2} \cdot \text{s}^{-1}$ and 300 $\mu\text{E} \cdot \text{m}^{-2} \cdot \text{s}^{-1}$ (illumination: 40 klx and 20 klx), using a 6 : 1 mixture of fluorescent tubes (equal numbers of Natural and Daylight types) and incandescent lamps. The air exchange rates were 12 and 28 times an hour. It can be seen from the figure that the change in temperature had relatively little effect, while the air exchange rate and the radiation intensity had approximately equal effects.

The data presented here are only a minute part of the information required to clarify this problem. A solution for this problem is urgently required, and not just for energetical reasons. The most important goal is to make the CO₂ supply as accurate and reproducible

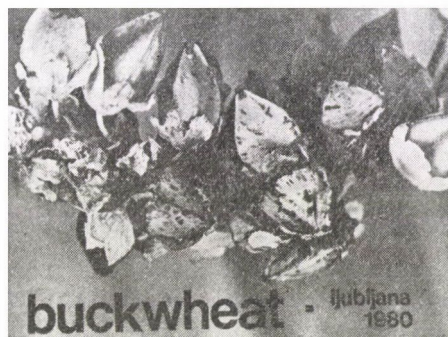
as possible at an acceptable cost. Make-up air systems can be considered as a make-shift solution compared to the more accurate, but extremely expensive regulating systems, but the make-shift nature of the solution must not be used as an excuse for failing to make optimum use of the possibilities available.

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RECENSIONES



Buckwheat, Ljubljana, 1980. Ed. (I. KREFT, B. JAVORNIK, B. DOLINSEK)

Parallel to the major grain crops, plant species of minor or local importance have been investigated and included in breeding more and more intensively over the past few decades. In the northern part of the temperate zone of Asia, where the vegetation period is too short to grow spring cereals, or as a second crop in Europe, there may be some justification for growing buckwheat (*Fagopyrum esculentum* Mönch). The production area of buckwheat has gradually decreased over the past century. However, the new, more productive varieties appearing as a result of the genetic and physiological research and breeding carried out in a number of countries may slow down or even halt this process.

The publication contains the material of twelve lectures on the most important fields of research delivered at the international Buckwheat Symposium held between 1st and 3rd September 1980 in Ljubljana.

The central problem of buckwheat breeding, the possibility of increasing productivity, is analysed by the Polish researcher M. Ruszkowski. The low seed setting percentage is the limiting factor of yield increase in

buckwheat, because the assimilation capacity of the plant is sufficient for the full development of many more seeds. Buckwheat is sporophytically self-incompatible; therefore, normal seed can only be obtained by cross-pollination. The plant produces a very large number of flowers, but only a fraction of them set seed. Seed setting is decisively influenced by the number of bees and the weather conditions at the time of flowering. The author is of the opinion that the seed setting percentage can probably only be improved by producing self-fertile forms. The author reports on the possibility of producing self-fertile homomorphous plants by crossing, and also discusses the conditions of inheritance.

The polyploidization of buckwheat has also been successful. The autotetraploid forms exhibit higher self-compatibility and productivity and more favourable agronomic properties.

T. Adachi and T. Yabuda produced autotetraploid plants with colchicin and subjected them to a detailed cytological examination. In the C_2-C_5 generations they examined changes in the chromosome number, while in the C_5-C_7 generations they studied the most important agronomical properties of tetraploid plants in comparison to similar parameters in diploid buckwheat and *F. tataricum* (L.) Gärtn.

N. V. Fesenko presents a survey of the genetic possibilities of buckwheat breeding. One method of breeding is to produce intervarietal hybrids. If appropriate parent partners are chosen and sown together, intervarietal hybrids with good productivity may be obtained as a result of cross pollination. Once self-fertile strains have been produced, it is possible to produce inbred lines and thereby achieve greater heterosis. The author summarizes the results attained so far in buckwheat breeding, gives a detailed analysis of yield, vegetation period, flower structure, seed setting, colour of flower and leaf, and seed structure in the hybrid progeny genera-

tion, and outlines the possibilities for further progress.

E. Gorina analysed the structure of the inflorescence, the dynamics of flowering, the variability of quality in the generative organs as a function of the time and site of flower formation, and the degree of fertility after various methods of pollination. The author then determined the correlations between various parameters of the inflorescence, used them to calculate the fertility index of the inflorescence, and finally elaborated a breeding method based on flower fertility.

O. Ohnishi and N. Katayama studied the frequency of male and female sterile mutants in Japanese buckwheat populations. The average frequency of the male sterile mutants was 9.5%, while that of the female sterile mutants was 17.3%. There was a great difference between the populations in the frequency of sterile mutants; the proportion of male sterile mutants ranged from 0.0 to 42.9% and, that of female sterile mutants from 5.0 to 38.1%. This does not agree with the frequency of chlorophyll mutations, which gives quite a constant value.

B. Dolinsek studied the polymorphism of the electrophoretic protein fractions of buckwheat. As opposed to earlier examinations he found great variability within the populations. One of the fractions was present in more than 70% of the self-pollinated thrum plants examined. Another fraction, on the other hand, was most frequently isolated from the self-pollinated pin plants. This suggests that the polymorphism of the electrophoretic protein fractions may be related to the heterostyle dimorphism of buckwheat.

I. Kreft give a brief historical survey of the cultivation of buckwheat and its economic importance in Yugoslavia. He introduces the populations found in the Yugoslav variety collection and describes their major characteristics. According to this author the ideotype of future buckwheat varieties has the following characteristics:

- larger assimilation surface,
- high flower fertility,
- short vegetation period,
- photoperiodic insensibility,
- frost tolerance,
- determinant growth,
- high quality.

The author summarizes methods of buckwheat breeding which can be used to achieve this aim. These are:

- selection from populations, or from progeny generations derived by crossing parents of different varieties,
- utilization of heterosis derived from the genetic heterogeneity of the population,

- inducing heterosis by crossing different populations or varieties,
- heterosis breeding using inbred lines,
- breeding of homomorphous varieties,
- inclusion of *F. tataricum* in breeding.

M. Bogdanovic gives an account of two-year agrotechnical experiments carried out with buckwheat in Bosnia and Herzegovina. Phenological data and yields at various rates of fertilization are given. The lecture was held in Serbo-Croat but followed by a short English summary.

V. P. Singh and Y. K. Mukhiya studied the toxic effect of three heavy metals, mercury, lead and manganese, in buckwheat. Their effects on germination percentage, pigment concentration, root and shoot length, fresh and dry weight, and on water absorption by the seed were evaluated. According to the results obtained, mercury and lead are highly poisonous, inhibiting the growth of the plant even at low concentrations. Manganese is less toxic at low concentrations.

B. Javornik and I. Kreft analysed the tissue structure of the buckwheat seed. They used a scanning electron microscope to study the position of the endosperm cells, the shape and size of the starch grains, and the aleuron layer.

B. O. Eggum compared the protein quality of buckwheat with other proteins of vegetal and animal origin. According to the examinations the amino acid composition of the buckwheat protein is highly favourable; its lysine content is higher than that of cereals. However, the protein content is rather low and its digestibility is not satisfactory either.

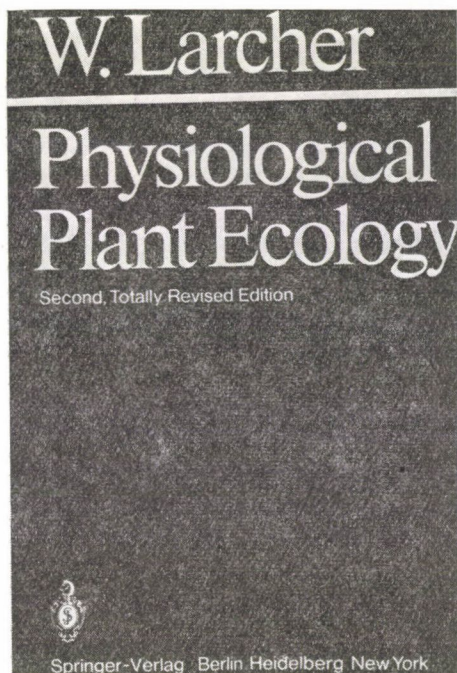
The composition of the protein in buckwheat is also the subject of B. Javornik's lecture. The author gives the amino acid composition, protein fractions and electrophoretic sub-fractions of different varieties.

At the Ljubljana conference researchers from various buckwheat-producing countries reported on the most recent results of buckwheat breeding. The publication offers a clear picture not only of the achievements but also of the difficulties involved in the work and of the possibility of attaining further successes.

L. LÁNG

W. LARCHER: *Physiological plant ecology*. Springer-Verlag, Berlin—Heidelberg—New York, 1980, 303.

The aim of ecology is to study all possible interactions existing between living organisms and their environment. This science deals with types of matter and energy trans-



port which make life on Earth possible and with the adaptation of organisms to the conditions under which they live.

Professor W. Larcher's book has great importance from the point of view that it presents data not only on the environmental effects on plants, but on their physiological responses to external influences as well. There can be no doubt that this book is the most excellent and unique among the scientific works published in this field recently. It gives a perfect summary of the available information and provides examples from all the climatic zones, taking into consideration both the historical background of plant ecology and the latest data.

Among the topics discussed the reader can find a description of the vital processes of plants, their metabolism and energy transformation, as they are affected by environmental factors, and the ability of these organisms to adapt to such factors.

The book consists of six chapters entitled: The Environment of Plants; Radiation and Temperature: Energy, Information, Stress; Carbon Utilization and Dry Matter Production; The Utilization and Cycling of Mineral Elements; Water Relations; Synopsis.

In the first chapter "The Environment of Plants" the author gives a brief outline of the different spheres of the Earth in which living organisms can exist, i.e. the hydro-

sphere, the atmosphere, the ecosphere, the lithosphere and the soil.

In the second chapter "Radiation and Temperature: Energy, Information, Stress" the effect of two important environmental factors — radiation and temperature — are summarized. It deals with all possible ways in which the radiation of the sun reaches the Earth and is distributed in the atmosphere and on the plant cover and how it can be taken up by plants. It analyses the photo-energetic, photocybernetic and photodestructive effect of radiation and the modulative, modificative and evolutive adaptations of plants to radiation. Information is given on the energy budget expressed in the radiation and thermal balance, the manners of heat storage and the exchange of energy with the surroundings. Furthermore, it describes the effect of temperature upon the vital processes, such as life-supporting range, survival limits, the temperature range for dry matter production, growth, development, heat requirement for reproductive processes and germination, temperature stress effects and cell death by heat and cold, freezing tolerance and hardening against frost, heat tolerance, and finally the distribution of heat and frost tolerance within the plant population. This chapter also presents data on the physiology of periodicity, the daily and annual rhythmicity of plant life.

The third chapter: "Carbon Utilization and Dry Matter Production" acquaints the reader with the pathways of carbon metabolism in the cell, namely photosynthesis (in which the radiant energy of the sun is absorbed and transformed into chemical energy and then used in organic CO_2 fixation from air and water), photorespiration and catabolic processes in different types of plants and in the different organs of individual plants representing different climatic zones. Other important results show the manners of CO_2 exchange of plants. This exchange is influenced by the diffusion possibilities of the plants; the size, shape, number and distribution of stomata and the effect of external factors, such as light, temperature, water supply and mineral nutrition. The carbon budget of the plant can be characterized by dry matter production, and the utilization and translocation of assimilates. However, if the carbon budget of plant communities is considered, it is composed of the productivity of plant stands expressed with reference to the area of ground covered (in tons of organic dry matter per hectare), the carbon balance in plant communities determined from the difference between intake and output, the net community production and the energy conversion by the vegetation, which is connected with the ratio of the conversion of

radiant energy to chemical energy during photosynthesis.

The fourth chapter is "The Utilization and Cycling of Mineral Elements". Plants require a large number of inorganic elements derived directly from minerals or mineralized by the decay of organic matter. The mineral nutrients are taken up in the form of ions and incorporated into the plant mass or stored in the cell sap. Some of them are essential for life, while others are trace elements or micronutrients. This chapter summarizes the ways in which mineral nutrients can be found in soil, how they can be taken up by plants, the role of mineral nutrients in plant metabolism, the translocation, distribution and incorporation of macro- and micronutrients in plants, what their function is, and how they are eliminated. The author pays special attention to nitrogen utilization and metabolism, as among the macrounits, nitrogen is especially significant. The nitrogen taken up is incorporated into carbon compounds in amino groups, forming amino acids. Amino acids are the basic compounds from which proteins, nucleic acids and other nitrogen compounds are synthesized. Therefore, the nitrogen uptake, assimilation, distribution in the plant, excretion and types of fixation are presented. The second part of this chapter gives information and examples on the habitat-related aspects of mineral metabolism, i.e. the fact that plant species require certain definite minerals for their

metabolism. The physiological processes are also influenced by the salt concentration through the osmotic effect, the specific ionic effect and salt stress. Finally, the toxic effect of environmental pollutants, as well as the mineral balance and circulation in plant communities is presented by comparing different plant types and different regions of the world.

The fifth chapter: "Water Relations" informs us of the role of water in plant life. As is well known, life evolved in the water and water remains the essential medium in which biochemical processes take place; plants too are composed mainly of water.

Depending on whether or not terrestrial plants can compensate for short-term fluctuations in the water supply and on the rate of evaporation they can be differentiated as poikilohydric and homoiohydric plants. In this chapter the reader can also find a summary of the data published in connection with the water relations of plant cells, the processes of absorption and transpiration in plants, the development of the water balance in plants and the effect of the environment on water relations.

The sixth chapter "Synopsis" gives a good review of the possibilities of analysing ecological factors, which method should be used in experimental ecology and how the data obtained in experiments can be presented.

I. KOVÁCS

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INDEX

F. Herdi: MCPA induced tissue changes in sunflower (<i>Helianthus annuus</i> L.) leaves	5
J. Mikulás: Effect of planting depth on the regeneration of rhizomes in <i>Sorghum halepense</i> (L.) Pers.	17
E. Haraszti, J. Vetter: Studies of factors influencing the nutritional value, palatability and toxicity of different lupine seeds	23

VARIA I

R. Horváth, K. Prohászka: Changes in the nutrient content of grass in response to certain soil properties	37
L. Balla: Regulation of the development of winter wheat varieties using short day illumination and low temperature	42
F. Nyujtó, S. Brózik Sr., J. Nyéki, S. Brózik Jr.: Flowering in apricot varieties	46
M. Molnár-Láng, E. Rajki: Effect of the age of the pistil on the tissue structure of the developing grain in cytoplasmic male sterile wheats	58
A. Régius-Möcsényi, S. Szentmihályi: Macro- and trace elements contents in alfalfa	63
J. Szejtli, M. Tétényi, E. Rajki: Effect of cyclodextrin treatment on the development and yield of wheat	74
E. Tóth, B. R. Bakheit: Results of resistance breeding in alfalfa II. Resistance to <i>Verticillium</i> wilt	78
E. Szűcs, I. Molnár, I. Szöllősi, Á. Weber-Forgony, I. Dávid: Effects of maize silage and alfalfa hay on nutritional behaviour and milk production of dairy cows	85
I. Óváry, J. Nemes Nagy, Z. Puskás, É. Csonka, Z. Kosztolányi, É. Kádár, I. Németh: Morphometry of monolayer tissue cultures II.	96

VARIA II

A. A. Abd El-Hafez: Types of dominance of fruit characteristics in various F ₁ hybrids in watermelon, <i>Citrullus lanatus</i> Thunb.	107
A. M. A. Wahab, H. H. Zahran: The effect of water stress on N ₂ (C ₂ H ₂)-fixation and growth of <i>Medicago sativa</i> L.	114
A. Bhattacharya, D. N. Singh, L. K. Grangal: Selection parameter against low temperature stress in rice (<i>Oryza sativa</i> L.)	119
S. C. Datta, S. P. Sinha-Roy: Characteristics of an inhibitory factor from <i>Croton bonplandianum</i> Baill.	124
V. R. Pal, M. C. Saxena: Symbiotic vs. fertilizer nitrogen for crude protein and oil production in soybean [<i>Glycine max</i> (L.) Merr.]	130
S. M. Abo Korah, A. A. Osman: The tarsonemid mite (<i>Tarsosemina</i> , <i>Heterostigmata</i>) under certain field crops in the Menoufia governorate, A.R.E.	134
R. Nath, K. G. Mukerji: Microbial ecology of the morphactin-treated leaves of <i>Crotalaria juncea</i> L.	138
S. Thimmegowda: Nitrogen nutrition to green gram (<i>Phaseolus aureus</i> L.)	139
A. A. Abd El-Hafeez: Comparative ET studies on berseem Clover grown at different water table depths. II. Under irrigation conditions	142
M. Skorpiak, J. Rod, V. Sip, J. Sehnalova, J. Kosner: Coloured wheat from the effects of E. Tschermak	147

<i>V. Rankov, G. Dimitrov, V. Barov</i> : Analysis of the influence of nitrogen fertilization on the proteolytic activity of certain soils	157
<i>M. Salehuzzaman, M. S. Alam, M. K. Pasha</i> : Influence of seed size on soya bean performance	162
<i>R. J. Alvarez</i> : Intestinal sucrase activity of growing chickens fed final molasses	165
<i>R. Rajendran, P. R. Ramachander, A. Satyanarayana, V. R. Srinivasan, K. Srinivasan</i> : Genetic improvement of cowpea [<i>Vigna unguiculata</i> (L.) Walp]. Green pod yield	167
<i>K. Veverka</i> : Effect of pelleting on water uptake and the germination of sugar beet seed	173
<i>Y. P. Gupta</i> : Studies on the utilisation of phosphorus by pea at different stages of growth using labelled superphosphate	180
<i>V. S. Verma, S. Singh, R. Padma</i> : Mosaic disease of <i>Coccinia indica</i> Wight and Arn. ..	182

FORUM

Our guest is István Szabó president of the National Council of Co-operative Farms (<i>Gy. Pál</i>)	185
--	-----

CHRONICA

<i>K. Nyéki, Gy. Sárhidai</i> : Prince Miklós Odescalchi	193
--	-----

AS I SEE IT...

<i>L. Oláh</i> : Present and future of grape production in Hungary	221
--	-----

LECTIONES

<i>S. Rajki</i> : Grain production and the future of the human race	233
<i>L. Veress, L. Lovas, L. Raduai, L. Végh, J. Turai</i> : Effect of raising conditions on prolificacy in ewes	244
<i>T. Tischner</i> : The effect of fresh air on the CO ₂ level of phytotron units	248

RECENSIONES

Buckwheat (<i>L. Láng</i>)	253
<i>W. Larcher</i> : Physiological plant ecology (<i>I. Kovács</i>)	255

INDEX

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INDEX

Fasc. 1—2

<i>F. Herdi</i> : MCPA induced tissue changes in sunflower (<i>Helianthus annuus</i> L.) leaves	5
<i>J. Mikulás</i> : Effect of planting depth on the regeneration of rhizomes in <i>Sorghum halepense</i> (L.) Pers.	17
<i>E. Haraszi, J. Vetter</i> : Studies of factors influencing the nutritional value, palatability and toxicity of different lupine seeds	23

VARIA I.

<i>R. Horváth, K. Prohászka</i> : Changes in the nutrient content of grass in response to certain soil properties	37
<i>L. Balla</i> : Regulation of the development of winter wheat varieties using short day illumination and low temperature	42
<i>F. Nyujtó, S. Brózik Sr, J. Nyéki, S. Brózik Jr.</i> : Flowering in apricot varieties	46
<i>M. Molnár—Láng, E. Rajki</i> : Effect of the age of the pistil on the tissue structure of the developing grain in cytoplasmic male sterile wheats	58
<i>A. Régius-Möcsényi, S. Szentmihályi</i> : Macro- and trace element contents in alfalfa	63
<i>J. Szejtli, M. Tétényi, E. Rajki</i> : Effect of cyclodextrin treatment on the development and yield of wheat	74
<i>E. Tóth, B. R. Bakheit</i> : Results of resistance breeding in alfalfa II. Resistance to <i>Verticillium wilt</i>	78
<i>E. Szücs, I. Molnár, I. Szöllősi, Á. Wéber-Forgony, I. Dávid</i> : Effects of maize silage and alfalfa hay on nutritional behaviour and milk production of dairy cows	85
<i>I. Óváry, J. Nemes Nagy, Z. Puskás, É. Csonka, Z. Kosztolányi, É. Kádár, I. Németh</i> : Cell volume of monolayer tissue cultures and its morphometrical analysis II.	96

VARIA II.

<i>A. A. Abd El-Hafez</i> : Types of dominance of fruit characteristics in various F ₁ hybrids in watermelon, <i>Citrullus lanatus</i> Thumb.	107
<i>A. M. A. Wahab, H. H. Zahran</i> : The effect of water stress on N ₂ /C ₂ H ₂ -fixation and growth of <i>Medicago sativa</i> L.	114
<i>A. Bhattacharya, D. N. Singh, L. K. Grangal</i> : Selection parameter against low temperature stress in rice (<i>Oryza sativa</i> L.)	119
<i>S. C. Datta, S. P. Sinha-Roy</i> : Characteristics of an inhibitory factor from <i>Croton bonplandianum</i> Baill.	124
<i>V. R. Pal, M. C. Saxena</i> : Symbiotic vs. fertilizer nitrogen for crude protein and oil production in soybean (<i>Glycine max</i> (L.) Merr.)	130
<i>S. M. Abo Korah, A. A. Osman</i> : The tarsonemid mite (<i>Tarsonemina</i> , <i>Heterostigmata</i>) under certain field crops in the Menoufia governorate, A. R. E.	134
<i>R. Nath, K. G. Mukerji</i> : Microbial ecology of the morphactin-treated leaves of <i>Crotalaria juncea</i> L.	138
<i>S. Thimmegowda</i> : Nitrogen nutrition to green gram (<i>Phaseolus aureus</i> L.)	139
<i>A. A. Abd El-Hafeez</i> : Comparative ET studies on berseem Clover grown at different water table depths. II. Under irrigation conditions	142
<i>M. Skorpik, J. Rod, V. Sip, J. Sehnalova, J. Kosner</i> : Coloured wheat from the effects of E. Tschermak.	147
<i>V. Rankov, G. Dimitrov, V. Barov</i> : Analysis of the influence of nitrogen fertilization on the proteolytic activity of certain soils	157
<i>M. Salehuzzaman, M. S. Alam, M. K. Pasha</i> : Influence of seed size on soya bean performance	162
<i>R. J. Alvarez</i> : Intestinal sucrase activity of growing chickens fed final molasses	165
<i>R. Rajendran, P. R. Ramachander, A. Satyanarayana, V. R. Srinivasan, K. Srinivasan</i> : Genetic improvement of cowpea (<i>Vigna unguiculata</i> (L.) Walp). Green pod yield ..	167

K. Veverka: Effect of pelleting on water uptake and the germination of sugar beet seed ..	173
Y. P. Gupta: Studies on the utilisation of phosphorus by pea at different stages of growth using labelled superphosphate	180
V. S. Verma, S. Singh, R. Padma: Mosaic disease of <i>Coccinia indica</i> Wight and Arn.	182

FORUM

Our guest is István Szabó president of the National council of Co-operative Farms (Gy. Pál)	185
---	-----

CHRONICA

K. Nyéki, Gy. Sárhidai: Prince Miklós Odescalchi	193
--	-----

AS I SEE IT...

L. Oláh: Present and future of grape production in Hungary	221
--	-----

LECTIONES

S. Rajki: Grain production and the future of the human race	233
L. Veress, L. Lovas, L. Raduai, L. Végh, J. Turai: Effect of raising conditions on prolificacy in ewes	244
T. Tischner: The effect of fresh air on the CO ₂ level of phytotron units	248

RECENSIONES

Buckwheat (L. Láng)	253
W. Larcher: Physiological plant ecology (I. Kovács)	255

INDEX

Fasc. 3—4

J. Vörösbaranyi: Effect of prolonged use of herbicides on the cellulose-decomposing activity of soil micro-organisms	257
--	-----

VARIA I.

I. Óváry, É. Csonka, A. S. Koch, J. Nemes-Nagy, Z. Puskás, S. Fazekas, Z. Kosztolányi, É. Kádár: Morphometry of monolayer tissue cultures III. Topologically adequate space of pixels as a supraindividual vista point	261
L. Balla: Regulation of the development of winter wheat varieties using long day illumination and high temperature	269
E. Szücs, I. Molnár, Á. Weber-Forgony, I. Szöllősi, L. Kishonti: Effects of feeding milk from nipple-pails or buckets in calf rearing	273
Z. Bedő, L. Balla, A. Ábrányi: Inheritance of heading date in stem rust resistant wheat varieties, and disease escape	284
F. Herdi: Histological changes in the leaf of sunflower (<i>Helianthus annuus</i> L.) in response to 2,4-D treatments	288
Á. Régius-Möcsényi, J. Várhegyi: Mineral composition of some economically important grass species	297
T. B. Szarvas, B. I. Pozsár, L. P. Simon: Detection of endogenous, free formaldehyde in plants and its relationship with photosynthesis	313
Zs. Lassányi, P. Tétényi: Use of microphotometry for histochemical studies on the cell walls of laticifers in <i>Papaver somniferum</i> L.	330
J. Dohy, I. Boda, Á. Kovách: Data on the reduction in improving effect of A. I. bulls in relation to the genetic trend of the population	335

VARIA II.

A. A. Abd El-Hafez: Inheritance of marker genes for leaf colour and shape in watermelon, <i>Citrullus lanatus</i> , Thumb	343
---	-----

S. N. Maiti, P. Datta, S. R. Biswas, S. Sen: A study of growth pattern in jute (<i>Corchorus olitorius</i> L.)	348
V. P. Singh: Inhibition of carotenoid biosynthesis in <i>Cucurbita pepo</i> L. cotyledons by Flurenol (EMD-IT 3233)	356
V. Adinarayana, M. S. Gangwar, R. S. Sachan: N, P and K requirement for targetted yields of potato (<i>Solanum tuberosum</i> L.) in Mollisol of Uttar Pradesh, India	359
K. Srivastava, A. K. Randhawa: Eco-physiological exploitation of triticales seeds with pre-sowing treatments to develop hardiness against moisture stress	362
A. M. Ahmed, M. D. Heikal, M. A. Shaddad: Changes in growth, photosynthesis and fat content of some oil producing plants over a range of salinity stresses	370
B. P. Singh, B. A. Phillips: Seasonal nodule activity profile of field grown soybeans	375
M. R. Gabal: Effect of N-doses, N-form and day temperature on nitrate accumulation in sweet peppers	377
A. A. M. Abd El-Moneim: Stimulative effect of heat treatment on germinative ability in annual <i>Medicago</i> species	387
M. H. El-Sawak: Influence of soil types, pre-sowing seed treatments, available amounts of soil nutrients and their combinations on tomatoes. II. Effect on mineral status of seedlings and leaf pigment contents	392
N. Jaim, R. B. R. Yadawa: Effect of 2,4-dichlorobenzyl tributyl phosphonium chloride (Phosfon-D) on growth, flowering and yield of oat in a pot culture	401
S. H. Mossa: Observations on codling moth fecundity, egg production and longevity	406
B. Sasmal, K. M. Sarkar, S. P. Banerjee: Intergenotypic competition in jute (<i>Corchorus</i> ssp.)	411
F. A. Salih: Effects of row and plant spacing on kenaf yield and its components in the Kenana area of the Sudan	416
B. R. Bakheit, E. Toth: Results of resistance breeding on alfalfa I. Resistance to <i>Fusarium wilt</i>	424

FORUM

Our guest is Mr Ferenc Donath Former Under-Secretary of State at the Ministry of Agriculture of the Hungarian People's Republic (Gy. Pál)	431
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CHRONICA

D. Cs. Veress: The agriculture of the Mezőföld region in 1928—1937	437
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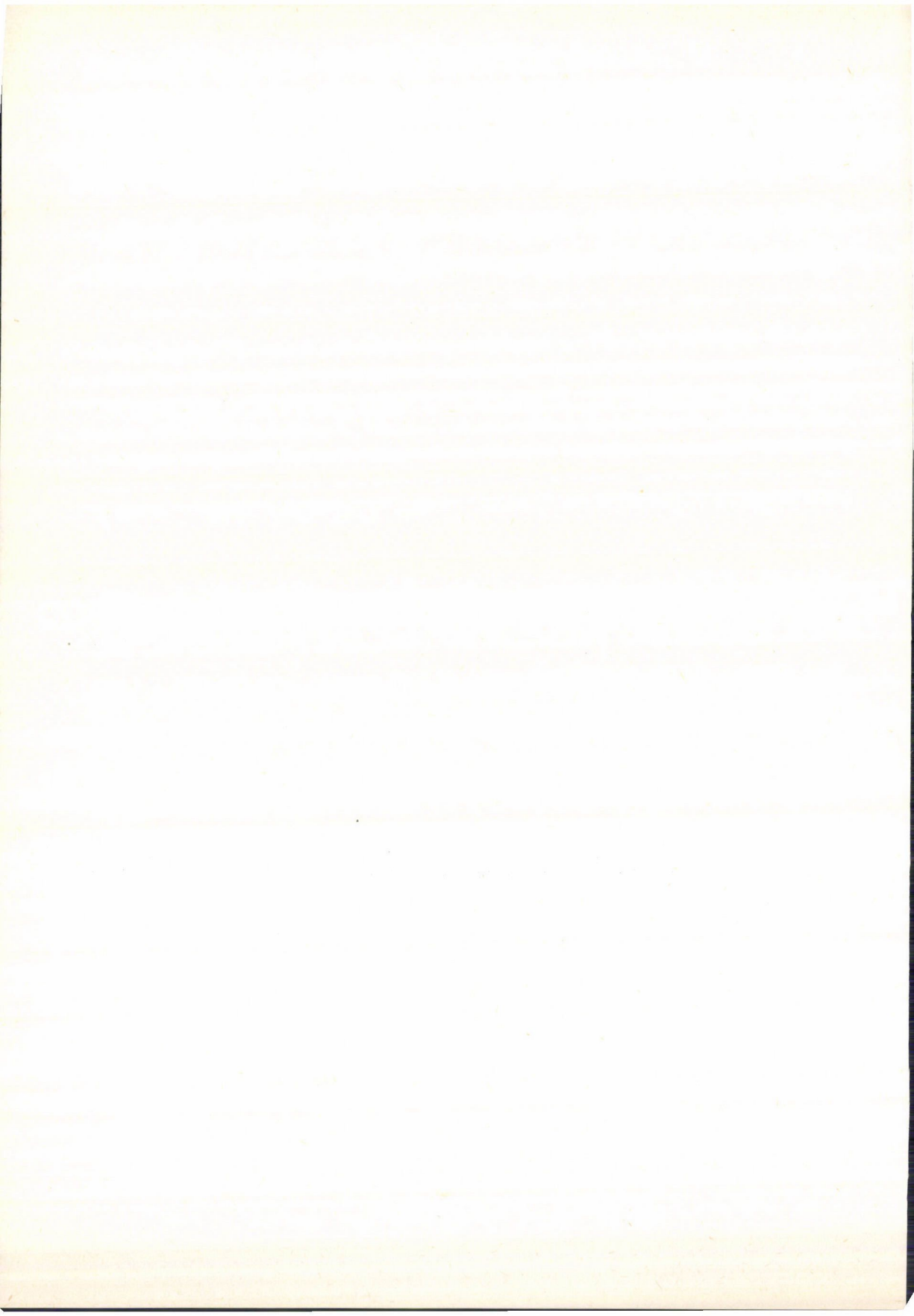
AS I SEE IT...

B. Keresztesi: Forest policy in the Hungarian People's Republic	463
---	-----

RECENSIONES

Agrotecnia de Cuba (S. Tuboly)	477
A. E. Hall-G.H. Cannel-H. W. Lewton: Agriculture in semi-arid environments (M. Kovács)	479

INDEX



EFFECT OF PROLONGED USE OF HERBICIDES ON THE CELLULOSE-DECOMPOSING ACTIVITY OF SOIL MICRO-ORGANISMS

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In this study the effect of using 7 herbicides regularly for 13 years on the total cellulose-decomposing capacity of the soil was examined under cultivated and uncultivated conditions. In the soil of plots which were ploughed every year, atrazine, simazine and prometryne did not cause a significant change in the cellulose-decomposing activity of the soil even when used over long periods, while monolinuron, linuron, ametryne and 2,4-D strongly reduced this activity. When soil cultivation was omitted, the negative effect of the herbicides (with the exception of atrazine and simazine) became much more pronounced. Compared to the decomposition measured in the soil of cultivated plots a considerable reduction (56.07% for ametryne) was observed. It is noteworthy that the two chlortriazines (simazine and atrazine) did not cause a significant change even after 13 years of use under no tillage conditions

Introduction

Large quantities of herbicides regularly introduced into the soil may cause profound changes in the qualitative and quantitative aspects of soil micro-organisms. It is difficult to simulate the effect of using individual herbicides for a prolonged period by introducing a single, extremely large dose of the herbicide into the soil, since regular use over a number of years results not only in the presence of the herbicide quantity but also in that of metabolites of the herbicide in various stages of decomposition.

There are some data on the prolonged use of herbicides (VOETS *et al.* 1974, HUSÁROVÁ 1975, KOLESNIKOV-SIDOROV 1978), but these deal mainly with changes in the activity of a particular enzyme or type of microbe.

The problem must thus be approached primarily from an agricultural point of view, where the emphasis is not on the quantitative or qualitative changes in the various types of microbes, but on the sum of those processes taking place in the soil which affect the intensity of the humification of the large mass of ploughed-in plant residues (maize stalks, roots).

Consequently, the aim of the present study was to evaluate the effect of using certain herbicides over a period of 13 years on the total cellulose-decomposing capacity of the soil, both with annual ploughing and after 13-years of no tillage.

Material and Methods

At the Agricultural Research Institute of the Hungarian Academy of Sciences, Martonvásár, experiments have been in progress since 1964 to study the effect of the prolonged use of 7 herbicides on the development of the weed cover. The herbicides tested and the doses applied are as follows:

Atrazine (Gesaprim)*	5.00 kg a.i./ha
Simazine (Gesatop)*	5.00 kg a.i./ha
Ametryne (Gesapax)*	5.00 kg a.i./ha**
Prometryne (Gesagard)*	5.00 kg a.i./ha**
2,4-D (Dikonirt)*	2 × 1.40 kg a.i./ha
Monolinuron (Aresin)*	5.00 kg a.i./ha
Linuron (Afalon)*	5.00 kg a.i./ha

The same plots are treated with the same chemicals each year, without any change in the dosage. The experiment is set up in four replications. Of these, two are ploughed to a depth of 20–25 cm each autumn, while the other two have not been cultivated since the beginning of the experiment. The soil of the experimental area is a meadow chernozem, rich in humus (3.5–4.0% humus content). On each plot the only weed cover to be found is that expected from the nature of the various herbicides. No crops are grown on the plots. The soil of these plots was used in the present study.

In order to analyse the cellulose-decomposing capacity of the soils, soil samples were taken from 25 points, arranged diagonally, in each plot. The samples were air dried, the organic residues were removed, and the soil was ground to a powder. Four 300 g samples, corresponding to the number of replications, were taken from each soil, and the structure of the soils was re-formed by mixing them with distilled water to 50% of the maximum water capacity in porcelain vessels. The soils prepared in this manner were put into plastic boxes without lids to ensure ventilation.

The cellulose specimens were prepared from Whatman No. 1 filter papers, by cutting out 6 × 6 cm pieces and sewing each of them 1 g into a fine-weave plastic fibre bag in an absolutely dry state. The specimens were placed vertically at a depth of 10 cm in the boxes, without compressing the soil, then all the boxes were put into a thermostat. Incubation was continued for six weeks at 29°C. At the end of the composting process the degree of cellulose decomposition was determined using Unger's method (UNGER 1960). The data obtained were evaluated by two-way analysis of variance on a Hewlett—Packard 9831A computer.

Results

Figure 1 shows the effect of the prolonged, 13-year use of the tested herbicides under ploughed conditions. The charts illustrate the degree of cellulose decomposition as a percentage of the cellulose introduced into the soil.

It can be seen from Fig. 1 that of the herbicides examined atrazine, prometryne and simazine did not cause any significant change in the cellulose-decomposing capacity of the soil under ploughed conditions even after such long use, while monolinuron, linuron, ametryne and 2,4-D caused a considerable reduction. In the case of 2,4-D the degree of decomposition was only 53.69% of the control. It seems probable that this inhibitory effect is not primarily due to a numerical change in the soil microflora, but due to profound adaptive changes in the composition of the soil micro-organisms as a con-

* Commercial name.

** From 1964 to 1971 2.5 kg a.i./ha.

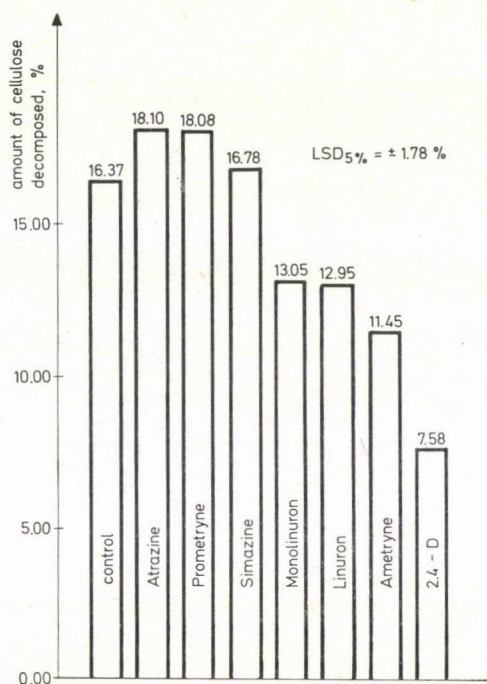


Fig. 1. Changes in cellulose-decomposing capacity after 13 years of herbicide treatment under cultivated conditions

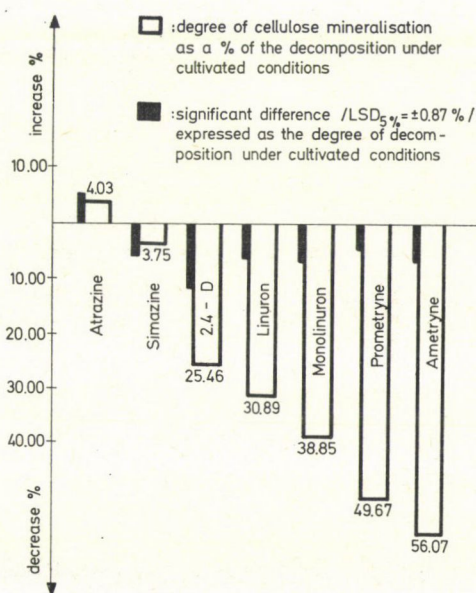


Fig. 2. Changes in cellulose-decomposing capacity after 13 years of herbicide treatment under no tillage conditions, compared to the cultivated plots

sequence of the regularly repeated stress effects caused each year by the concentration of metabolites. The fact that this unfavourable effect was not exhibited by atrazine, prometryne and simazine should definitely be taken into consideration when elaborating an optimum rotation of herbicides.

The result of a prolonged omission of soil cultivation is illustrated in Fig. 2, using the cellulose decomposition under ploughed conditions as the basis for comparison.

It can be clearly seen that atrazine and simazine show no response to the lack of cultivation. Even after 13 years of no tillage there was no significant change in the cellulose-decomposing activity of the soil compared to that of regularly cultivated soil. In the case of 2,4-D, linuron, monolinuron, prometryne and ametryne, however, long-term neglect of soil cultivation caused a significant reduction in the cellulose-decomposing capacity. The reduction in the case of ametryne was 56.07% compared to the value registered in ploughed soil. This negative effect may be related to the fact that under no tillage conditions, the compaction of the soil, the less water infiltration and the poorer aeration reduce the microbiological detoxication of herbicides, while the lack of ploughing means that the concentration of the herbicides and their metabolites in the upper layers of the soil rises sharply. Again, the two chlortriazines (simazine and atrazine) form an exception with respect to the negative effect. Even after being used for 13 years these herbicides did not cause a significant reduction in the cellulose-decomposing capacity of the soils under either cultivated or uncultivated conditions.

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VARIA I

MORPHOMETRY OF MONOLAYER TISSUE CULTURES III. TOPOLOGICALLY ADEQUATE SPACE OF PIXELS AS A SUPRAINDIVIDUAL VISTA POINT

1.0 Introduction

The mathematical methods used for the morphometric analysis of monolayer tissue cultures transform the phenomenological visual reality into an abstract system (COHEN 1971, CRICK 1971, FOHLMEISTER *et al.* 1974, HERMANN—WU HUNG 1978, JUHÁSZ-NAGY—VIDA 1978, KELLER—SEGEL 1971, KOCH 1979, LINDENMAYER 1978, ROGERS 1977, WINFREE 1980). In order to prove the realistic value of the abstract system the second distance lattice maps were compared with the photomicrographs of the original tissue culture.

1.1 Materials and methods

The tissue cultures mapped by direct density evaluation were re-evaluated on photomicrographs. The latter were taken by means of a Zeiss (Jena) Docuval microscope at $3.2\times$ and $10\times$ objective magnification. Using a $6.3\times$ — $25\times$ zoom (vario) ocular in the microscope a continuous change of linear magnification was made possible. To ensure correct and reproducible magnification of the micrographs an object micrometer was used as a reference bar. The individual micrographs were mounted into a survey map giving the order of the joining second distance lattices. The cell counts per pixel were established and the results compared to those obtained by direct counting in the impregnated tissue culture slides.

2.1 Results

Only microscopically homomorphic "healthy" cultures were subjected to morphometric analysis by computer. BHK 21 fibroblast cultures are known to grow in a whorl-like manner and to form ellipses and circles (Figs 1, 2, 3 and 4). The second distance lattice is rectangular with a unit edge length of 1750×1200 micrometres. Each unit may contain 3—4 circles or ellipses, formed by the growing cells. A unit "cell" of the second distance lattice contains 25 pixels. Each pixel is 240×350 micrometres in size. Direct and micrograph cell countings yielded essentially identical results, the cell count per pixel being:

minimum	40— 50,
maximum	4000—5000,
mean	400— 500 fibroblasts.

It is clear that the rectangular lattice analysis of the cultures is based rather on an arbitrary "political" than on a natural "geographical" principle of mapping. This causes a certain "skewness" in the density map relative to the real pattern of density. This skewness is,

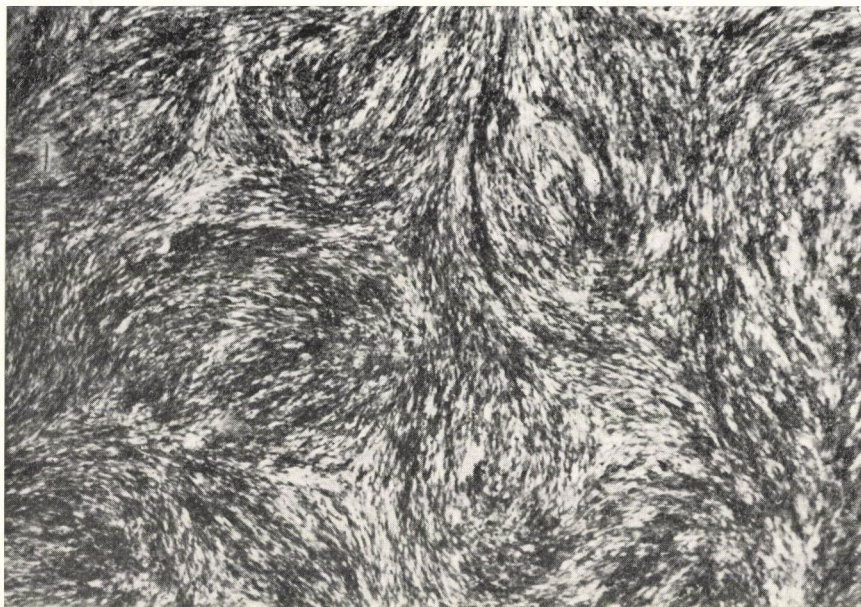


Fig. 1. 2 + 6-day-old fibroblast culture, $\text{CuCl}_2 : 5 \times 10^{-7}$ Mcc., $3.2 \times \text{obj.}$, $10 \times \text{oc.}$, $y = 2100 \mu\text{m}$.

Regular and partially distorted ellipse aggregation, different in size though of the same order of magnitude, in the culture. The relative decrease in cell density in areas between the higher units, and the development of compact regions (ranges) between the marginal zones are noteworthy

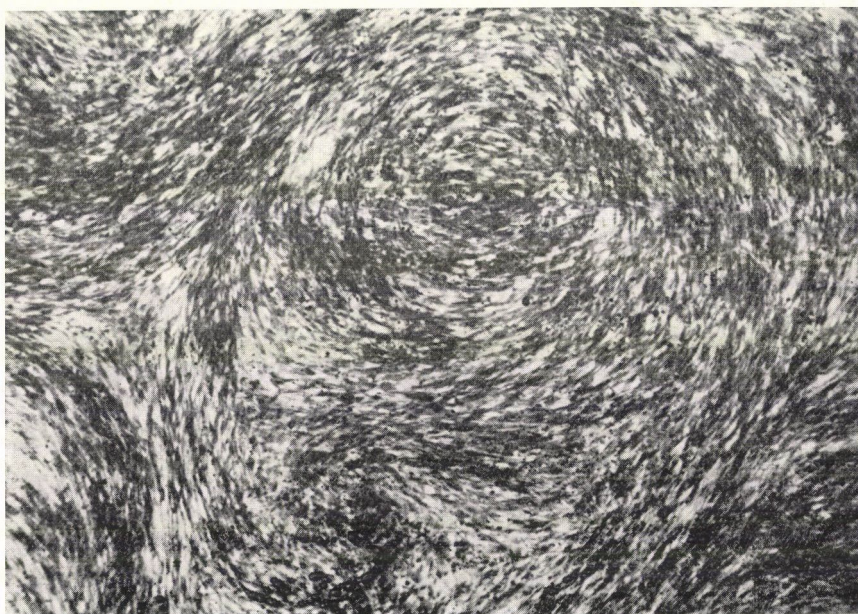


Fig. 2. 2 + 6-day-old culture, $\text{CuCl}_2 : 5 \times 10^{-7}$ Mcc., $3.2 \times \text{obj.}$, $15 \times \text{oc.}$, $y = 1480 \mu\text{m}$. In the upper part of the field there is an almost completely closed ellipse with the lower part turning into a partly disorganised ellipse. The two structures merge into a shape resembling a question mark

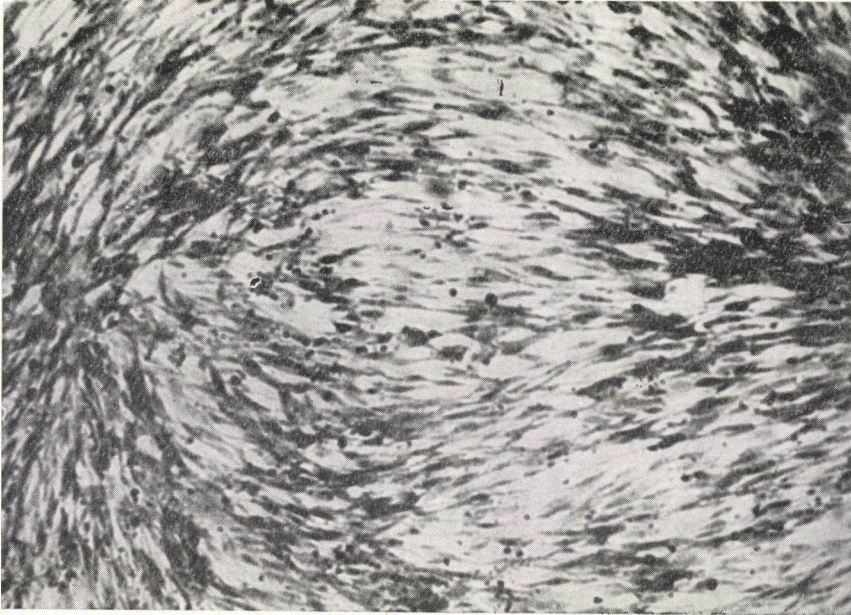


Fig. 3. 2 + 6-day-old culture, $\text{CuCl}_2 : 10^{-7}$ Mcc., $10\times$ obj., $10\times$ oc., $y = 700 \mu\text{m}$. Detail of the inner zone of the ellipse (higher unit). The bisector drawn in the horizontal plane passes through the two focuses of the ellipse. The right-hand side focus is found at the right edge of the picture in a halved form, the left-hand side one 1.5 cm in from the edge of the field. The "isogradients" between the two focuses can be recognised in the form of fibroblast bundles

however, partly corrected when considering the second distance lattice. A considerable part of this correction is already covered by the loss of the original kurtosis in the determination of the circular indices.

"Gradients" are determined at both the first and second distance lattices to act as further rasters correcting the skewness caused by the quadrangular lattice of mapping. The introduction of gradients into the evaluation of the basic density data makes it possible to take into account a number of physical factors (angular velocity, angular acceleration, oscillatory motion, etc.). This also has a biological meaning, since, in a cooperative association of cells, the cytoskeleton is the motor of the material transport (AYERS—SEVERSTON 1977, CHAPLAIN 1976, CHETVERIKOVA 1973, FRANCK 1973, GLASS—PASTERNAK 1978, GOLA 1976, GOODWIN 1974, GROSS 1975, GULKO—PETROV 1972, LATZKOVITS *et al.* 1980, ÓVÁRY *et al.* 1980, POMERAT *et al.* 1962, ROISEN *et al.* 1978, RUTTER—MANNWEILER 1977, SHIBATA—BURES 1972, SHIBATA—BURES 1974, SCHNOLL 1973, STUPFEL 1975, TUCKWELL—MIURA 1978, WILSON—COWAN 1972, WILSON—COWAN 1973, WILSON—WACHTEL 1974, WINFREE 1977).

From a physical point of view a pixel-space may be regarded as an electrostatic (electrodynamic) space, as a microgalaxy, or as a chemical oscillator (BENITEZ *et al.* 1955, CHETVERIKOVA 1973, KAWATO *et al.* 1979, KONDRASHOVA 1973, KÖRÖS—ORBÁN 1978, MADERSCHPACH 1980, ÓVÁRY—BENCZE 1965, ÓVÁRY 1969, WINFREE 1980).

Therefore, the differences in the adjacent circular indices may also be considered simply as phase shifts.

Relations between the ellipse units of the culture.

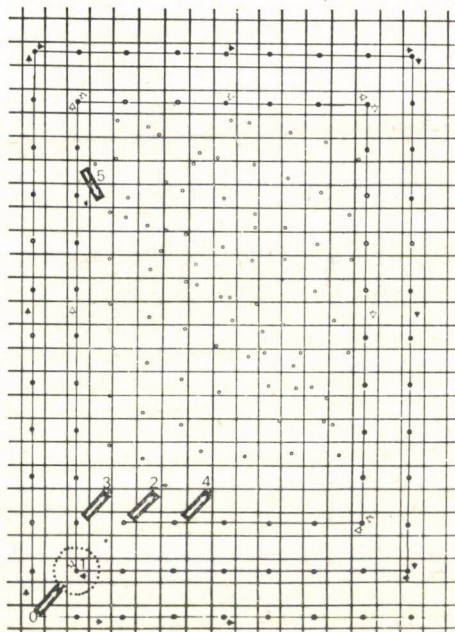


Fig. 4. See text for explanation

From the point of view of flux genesis the ellipse units of the culture may be regarded as higher units; they may act as "generators", i.e. sources of frequency. Their centres are analogous to the pacemakers of, for instance, the linked chemical oscillators. The distances between the higher units (generators) of the culture may be considered as representing the wavelength of the flux. If the distance between higher units is $\lambda/2$, or an integer multiple of it, the culture is supposedly in a state of optimum reflection: absolute synchronisation.

Consequently, if the distance between two higher units is $\lambda/4$, an interference is to be expected resulting in the absorption of the energy package emitted by the neighbouring higher unit.

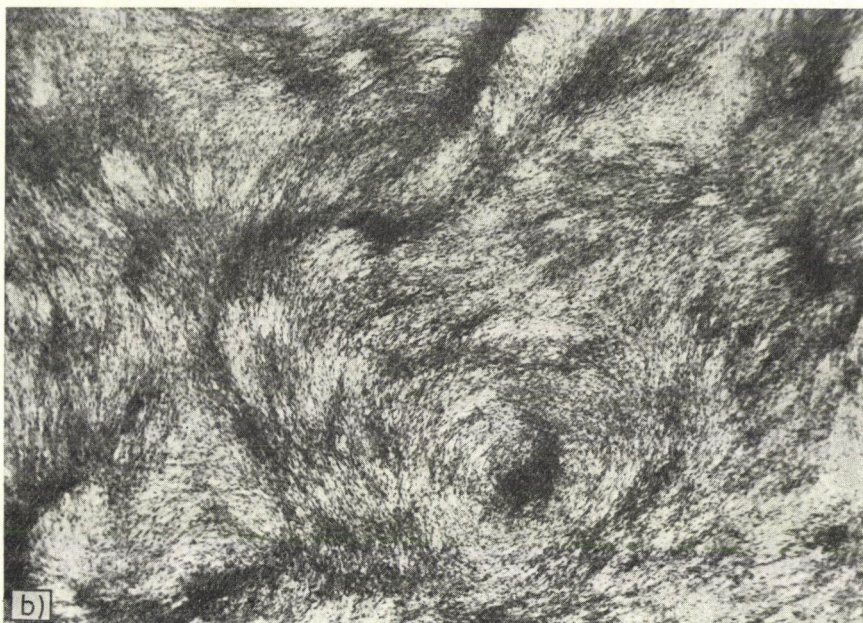
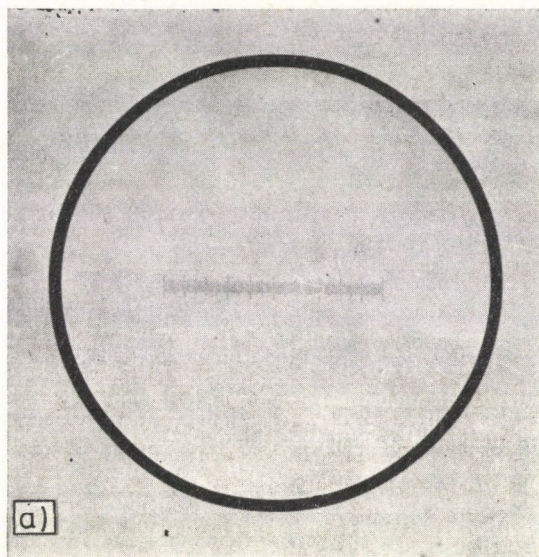
If in a cell the ability of synchronous growth is genetically determined, the $\lambda/2$ distance should be dominant in its cultures.

Modelling of growth on the basis of the flux wave concept

Let us take a quadrangular network with a side length of 17×25 unit squares (Fig. 4). Let us suppose that cell growth starts at the bottom left unit square. Let the side length of a unit square be $\lambda/4$, and the centre to centre distance between unit squares unity ($d = 1$).

Let us further suppose that $\lambda/4 = d$ and $\lambda/2 = 2d$. Suppose the cell growth starts from the bottom left corner orthogonally (within the actual network this means upwards). As soon as growth reaches the top left square, growth must either stop or continue in the other possible orthogonal direction, i.e. parallel to the top row of the network. This can again continue only till the edge, when it must turn 90 degrees again. This is continued until growth reaches the bottom right corner which is already occupied by growth, started horizontally from the bottom left corner. Thus, the direction of orthogonal growth has to change 90 degrees again,

and so on. The final result is a spiral growth pattern with a "radius" decreasing towards the centre. As soon as the space available for growth is less than $d = 2$, growth must either stop or continue orthogonally. It is certainly not necessary that orthogonal growth should continue until this end point. As soon as at least two neighbouring lines of orthogonal growth have developed an interaction between them becomes possible. This may gradually change the state of the system and induce growth in diagonal directions, too (framed arrows).



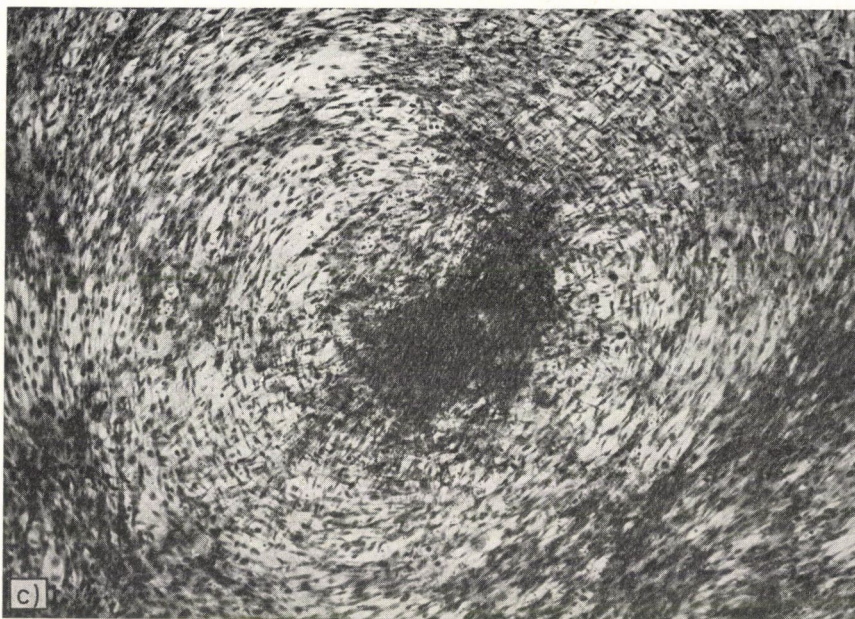


Fig. 5 (insert). a) Bar = 1.0 mm; b) BHK 21 fibroblast monolayer (8-day-old) magnified $23\times$. At the edge of the slide a well-organised ellipse is seen; the fibroblasts at its side form interference patterns; c) The size of the ellipse corresponds to the second distance lattice

In orthogonal growth the distance between two parallel lines is $d(\lambda/4)$, i.e. they lie in the zone of interference. The third parallel line is at a distance of $2d$ from the first one; thus, it represents a zone of reinforcement. In this way regionally different patterns of interference and reinforcement are formed, determining the further structural organisation of the culture as a whole (Figs 5a, b, c). The analogy with a dynamic electromagnetic field is obvious. It is a well-known fact that in an electromagnetic field the fibroblast tissue cultures become oriented in accordance with the lines of induction. In this case we may speak of growth being determined by an extraneous field, in contrast to the growth determined by factors intrinsic to the fibroblasts.

The whorl-like elliptical texture seen in the photomicrographs is evaluated during the scanning process in a rectangular lattice, on the basis of the density value, and averaged through relatively large areas by the computer. In this way a new, computer-produced raster of step-like granulation due to categorisation by density develops, giving a further, more abstract and sophisticated texture.

3.0 Discussion

Various methods of morphometric analysis were used to acquire a knowledge of the topologically continuous uniform supraindividual organisation of BHK 21 fibroblast cultures. The basic data of densities, as well as the data of surroundings analysis, potential analysis, nutrition-deprivation analysis and flow analysis can be interpreted in the second distance lattice even at lower magnification. The higher organisation levels of the cultures, the circles and ellipses, as well as the development of various patterns of wave interference result from the dynamics of orthogonal and diagonal growth. The cultures studied in this way show striking

ing analogies with a number of known chemical and physical phenomena. The regional peculiarities seem to be much more important than the simple end-products of the morphometric analysis, the mean and the standard deviation.

The results presented here are regarded as one of the initial steps towards learning something about the basic principles of in vitro supraindividual organisation of monolayer tissue cultures.

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REGULATION OF THE DEVELOPMENT OF WINTER WHEAT VARIETIES USING LONG DAY ILLUMINATION AND HIGH TEMPERATURE

If wheat varieties with different vegetation periods are to be crossed in the phytotron, the rate of development must be regulated to achieve nicking in the flowering times. This can be achieved by changing the photoperiod or the temperature or both. Previous papers (BALLA 1982a, b, c) have dealt with the effect of light, low temperature and a combination of these, while the present paper analyses the effect of long day and high temperature on wheat development.

The investigations were carried out in the phytotron at the Agricultural Research Institute of the Hungarian Academy of Sciences, Martonvásár. In this programme long day (22 hour) illumination and four temperature variants were used to regulate (accelerate) development. These were as follows:

- control, i.e. plants raised under normal illumination (gradually increasing from 13 hours 10 minutes to 16 hours) and at normal temperature (varying from 16/15 to 20/15°C day/night from planting to heading)
- long day illumination (22 hours, H)
- long day illumination (22 hours) + a temperature 3°C higher than in the normal programme (H + 3)
- long day illumination (22 hours) + a temperature 6°C higher than in the normal programme (H + 6)
- long day illumination (22 hours) + a temperature 9°C higher than in the normal programme (H + 9).

The illumination was provided by Gro-Lux/WS and Cool White fluorescent tubes, with an intensity of 20—25 thousand lux (400 $\mu\text{E}/\text{m}^2/\text{sec}$).

Three wheat varieties of different origin and with different vegetation periods were chosen for the investigations:

Rannyya 47: an early, winter hardy variety. Pedigree: (Mironovskaya 808 \times Bezostaya 1) \times Rannyya 12. Bred at Krasnodar, Soviet Union.

Bezostaya 1: a midseason, winter hardy variety, introduced into Hungary. Pedigree: Lutescens 17 \times Skorospelka 2. Bred at Krasnodar, Soviet Union.

Maris Huntsman: a late, winter hardy variety of northern origin. Pedigree: (CI 12633 \times Capelle D.₅) \times Hyb 46 \times (Capelle D. \times Prof. Marchal.). Bred at Cambridge, England.

The seeds of the varieties were germinated in Petri dishes, then planted into plastic tubes and vernalised in the seedling stage for 45 days in a chamber at 2°C under weak blue illumination. The plants were then transferred to pots and placed in a phytotron chamber (GB), where they were raised on the normal programme devised by S. and E. Rajki (for details, see BALLA 1980). The treatments were carried out based on the Feekes scale of development. When plants raised on the normal programme reached the appropriate stage of development they were transferred to another chamber (E 15 VH), with long day illumination and high temperature, as required by the treatment. The plants were kept there until they had completed the relevant phase of development.

The treatments can be divided into three groups:

1. Treatment over two phases of development (1—2, 3—4, 5—6, 7—8, 9—10.1).
2. Treatment over four or six phases of development (1—4, 5—8, 5—10).
3. Treatment from planting to heading (1—10.1).
4. Control, which was untreated.

The treatments consisted of 10 plants each with three replications. The effect of high temperature and long day illumination on the course of development was determined by

observing the heading date (number of days from planting to heading). The plants were kept under observation for 93 days, after which the investigation was terminated.

As a result of twice daily watering and a regular supply of nutrients two or three normally sized ears were obtained on average on each plant.

The effect of treatment in various stages of development on the number of days from planting to heading is shown in Table 1.

Table 1

Number of days from planting to heading under long day illumination at temperature 3, 6 and 9°C higher than the normal programme

Developmental phase	Rannyaya 47			
	Length of treatment days	H + 3°C	H + 6°C	H + 9°C
1— 2	9	62	64	72
3— 4	4	55	57	61
5— 6	12	51	49	50
7— 8	4	57	54	58
9—10.1	7	54	53	52
1— 4	16	62	62	78
5— 8	15	47	45	44
1—10.1	45	41	40	69
Control (normal temp. and illum. 1—10.1)			54	
Developmental phase	Bezostaya 1			
	Length of treatment days	H + 3°C	H + 6°C	H + 9°C
1— 2	9	62	70	69
3— 4	4	62	61	60
5— 6	14	50	50	54
7— 8	5	58	53	57
9—10.1	9	57	56	55
1— 4	15	60	73	97
5— 8	18	54	53	47
1—10.1	50	43	47	61
Control (normal temp. and illum. 1—10.1)			58	
Developmental phase	Maris Huntsman			
	Length of treatment days	H + 3°C	H + 6°C	H + 9°C
1— 2	9	77	79	81
3— 4	4	69	65	68
5— 6	14	56	53	55
7— 8	7	58	63	62
9—10.1	10	63	64	65
1— 4	20	73	73	100
5— 8	20	54	54	54
1—10.1	55	46	52	71
Control (normal temp. and illum. 1—10.1)			64	

Under normal illumination and temperature Rannyya 47 headed in 54 days. At first sight it is surprising that if this variety was raised under long day illumination at a temperature 3, 6 or 9°C higher than the normal programme in developmental phases 1—2, the vegetation period was not shortened but lengthened by 8, 10 or 18 days, respectively. H + 3 or H + 6 treatment in phases 3—4 caused no significant change in the vegetation period, while H + 9 induced a delay of 7 days.

Treatment in phases 5—6 accelerated the development of Rannyya 47 by about 4 days. There was no significant difference between treatment H + 2 and H + 9.

If the treatment took place in developmental phases 1—4 the vegetation period was again protracted, while treatment in phases 5—8 caused a significant shortening. It is interesting that in the latter case, there was only 3 days' difference between treatments H + 3 and H + 9.

Of the treatments continued from planting to heading, H + 3 and H + 6 significantly accelerated the development of this variety (by 13—14 days), while H + 9 significantly retarded it (by 15 days).

In the case of Bezostaya 1 the tendency was similar to that for Rannyya 47, though the individual treatments acted somewhat differently. Long day illumination and a temperature 3°C higher than normal (H + 3), applied in developmental phases 1—2, only slightly retarded development, while treatments H + 6 and H + 9 had a stronger effect, causing greater retardation. Treatment applied in phases 3—4 or 7—8 had no significant effect. Treatment in phases 5—6 resulted in a considerable shortening of the vegetation period. It is interesting to note that the effect of H + 3 and H + 6 was uniform, while that of H + 9 was less significant.

The effect of treatment carried out over developmental phases 1—4 again showed a contrast. H + 3 did not cause a significant difference, while H + 6 and H + 9, instead of reducing the number of days from planting to heading, significantly increased it. Treatment applied in developmental phases 5—8 acted as expected in accelerating development, i.e. in shortening the vegetation period.

When treatments H + 3 and H + 6 were applied from planting to heading (1—10.1) development was retarded, but H + 9 did not cause a significant difference compared to the control.

Maris Huntsman, which has a long vegetation period and is of northern origin, responded more intensely to the treatments than the other two varieties. On the normal programme (control) it headed in 64 days. If it was raised under long day illumination in phases 1—2 at a temperature 3, 6 or 9°C higher than normal, the number of days from planting to heading rose to 77, 79 or 81, respectively. Treatments applied in phases 3—4 also caused slight extensions of the vegetation period, but they had no effect in phases 9—10.1. An acceleration in development was achieved by using treatments H + 3, or H + 9 in phases 5—6 or treatment H + 3 in phases 7—8. In developmental phases 1—4 treatments H + 3 and H + 6 resulted in a significant extension of the vegetation period, but the effect of H + 9 was even more pronounced. Treatments applied in developmental phases 5—8 all caused a 10 day shortening of the vegetation period compared to the control.

When treatment was continued from planting to heading (1—10.1) H + 3 caused an 18 day reduction and H + 6 a 12 day reduction in the vegetation period, while H + 9 produced a 7 day increase.

Both the literary data and the present working hypothesis indicated that short day, low temperature or a combination of these would retard wheat development, while long day, high temperature or a combination of these would result in acceleration.

The data obtained for the varieties tested here, however, contradict the general statement with respect to development acceleration. If a combination of long day illumination and

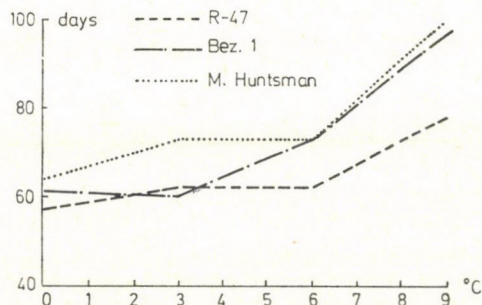


Fig. 1. Effect of long day + high temperature applied in development phases 1—4 on heading date

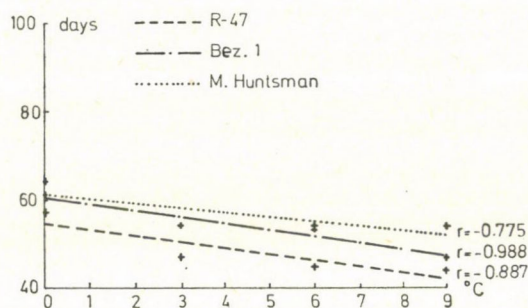


Fig. 2. Effect of long day + high temperature applied in development phases 5—8 on heading date

high temperature was applied in the early (1—4) phases of vegetative growth, the number of days from planting to heading increased instead of decreasing. This can be explained by the fact that winter wheat cannot be transferred straight from the vernalisation chamber at 2°C to a temperature 3, 6, or 9°C higher than the programme normally used (16/15°C). A transitional post-vernalisation period is required, which the tests show to last some 10—14 days. This coincides with the first four phases of the Feekes scale of development. If the treatment was carried out from the fifth developmental phase onwards it caused acceleration in every case.

The effect of H + 3 and H + 6 in developmental phases 1—4 was identical in Rannaya 47 and in Maris Huntsman, but different for Bezostaya 1 (60 or 73 days). H + 9 significantly increased the vegetation period of all three varieties. When these treatments were applied in developmental phases 5—8 they produced almost identical results. For Maris Huntsman H + 3 was just as effective as H + 6 or H + 9; for Bezostaya 1 H + 3 and H + 6 both had a medium effect, while H + 9 acted somewhat more strongly; for Rannaya 47 H + 3 had a medium effect, while H + 6 and H + 9 both produced an intense response. This can be explained by the difference in vegetation period between the varieties and/or their sensitivity to temperature.

The delaying treatments might be useful in retarding the development of early varieties, though the effect of these treatments seems at present to be unpredictable, so they are not to be recommended.

The effect of long day and high temperature is illustrated in Fig. 1. As the effect is unpredictable it is impossible to fit a regression curve to the points. Even so, the effect of

treatment in developmental phases 1—4 is clearly to be seen. The early variety Rannaya 47 and the midseason variety Bezostaya 1 gave a similar response to $H + 3$, while at $H + 6$ and $H + 9$ the response of Bezostaya 1 was similar to that of the late variety Maris Huntsman. Rannaya 47 is less sensitive to higher temperatures.

The effect of treatment in developmental phases 5—8 is linear, with a close correlation (Fig. 2). This figure again clearly indicates that Bezostaya 1 responds more sensitively to treatment than the other two varieties tested.

Using the treatments tested Bezostaya 1 can be made to flower simultaneously with either the early variety Rannaya 47 or the late variety Maris Huntsman, but nicking cannot be achieved between the latter two varieties. However, if the retardation methods described in earlier papers are used, the vegetation period of any of the varieties can be regulated by means of various treatments and nicking in the flowering times can be achieved (BALLA 1980).

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*

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EFFECTS OF FEEDING MILK FROM NIPPLE-PAILS OR BUCKETS IN CALF REARING

Ever since the introduction of artificial calf rearing, the question of whether nipple-pails or buckets are best used in large-scale calf rearing has been the subject of investigation both in Hungary and abroad. Since Leufven (ALEXANDER 1954) tested his nipple feeding apparatus, patented in America in 1894, in a nine-week experiment and found it more favourable than the bucket system from the point of view of weight increase, the question has remained undecided. Both systems of feeding milk undoubtedly have advantages and disadvantages with respect to weight gain, feed conversion, nutritional behaviour, daily rhythm of responses, development of life habits and the health condition of the calves, and even from the point of view of work organization.

Experiments were carried out with two groups of crossed dairy heifer calves. The individually rationed milk supplement was given from nipple-pails in group A and from buckets in group B. The calves were fed in this way even during the first few days of their lives.

Feed and nutrient intake. According to the data in Tables 1 and 2 feed consumption and nutrient intake were not influenced by the method of feeding.

Live weight and weight gain. The data in Table 3 show that at the beginning and end of the nearly identical periods of milk feeding and post-weaning, i.e. at the start and finish of the experiment, no significant differences were found between the two groups in the average weights of the calves ($P\% > 5$). In the milk feeding period calves in group A given the milk supplement from nipple-pails attained a significantly lower total and average daily weight gain than those in group B fed from buckets. In the post-weaning period no significant differences as regards weight gain were found. In fact, owing to the somewhat lower weight gain in calves fed from buckets, even their more favourable weight gain during the whole experimental period did not prove statistically demonstrable. On the basis of results obtained in three experiments carried out with fattened calves ECKHOUT-BUYSE (1969) found that when milk was fed from nipple-pails the feed consumption, and consequently the weight gain decreased considerably after a certain length of time compared to the bucket system. Calves fed by ALEXANDER (1954) from buckets also put on more weight than those given milk from nipple-pails. HOYER-LARKIN (1954) and WISE-LAMASTER (1968) did not observe any differences between the two forms of milk consumption as regards the weight gain of the calves. It was only in one of three experiments that KESLER *et al.* (1956) found bucket-fed

Table 1
Average feed and nutrient intake of calves

	Groups	
	A (sucking)	B (drinking)
<i>Feed intake</i>		
<i>in the milk feeding period</i>		
milk supplement, kg	64.15	69.44
grain fodder, kg	82.57	86.69
alfalfa hay, kg	88.42	84.89
<i>in the post-weaning period</i>		
grain fodder, kg	368.67	346.50
alfalfa hay, kg	331.18	322.00
<i>Nutrient intake</i>		
<i>in the milk feeding period</i>		
dry matter, kg	210.48	215.90
starch equivalent, kg	152.28	159.89
digestible crude protein, kg	40.30	41.87
<i>in the post-weaning period</i>		
dry matter, kg	622.93	594.39
starch equivalent, kg	340.62	323.11
digestible crude protein, kg	100.80	96.17
<i>Experimental total</i>		
dry matter, kg	833.41	810.29
starch equivalent, kg	492.90	483.00
digestible crude protein, kg	141.10	138.04

Table 2

Percentage distribution and percentage composition of fodder for calves

	Groups	
	A (sucking)	B (drinking)
<i>Distribution of fodder</i>		
<i>in the milk feeding period</i>		
Calf raiser, %	55.60	57.60
Fodder mixture I, %	44.40	42.40
<i>in the post-weaning period</i>		
Fodder mixture I, %	7.54	6.78
Fodder mixture II, %	92.46	93.22

Percentage composition of fodder mixture

Fodder mixture I		Fodder mixture II	
Calf raiser	30%	Barley	35 %
Barley	24%	Maize grain	22 %
Wheat bran	25%	Wheat bran	20 %
Maize grain	15%	Sunflower extr.	15 %
Alfalfa meal	5%	Alfalfa meal	6 %
Feed lime	1%	Feed lime	1.5%
		Feed salt	0.5%

calves to outweigh those fed from nipple-pails. BELIĆ—KRSTIĆ (1959) reported contrasting results. They found that calves fed from vessels furnished with rubber nipples attained a significantly higher (873 g) weight gain compared to those given milk from buckets (745 g). The results of our own investigations more or less agree with the statement that the manner of milk consumption (drinking, sucking) only influences the weight gain of calves in the milk feeding period and has little connection with it later, in the post-weaning period. The significant difference in weight gain between the two groups in favour of artificially fed calves disappeared during post-weaning.

Nutrient conversion. In agreement with the data of ECKHOUT—BUYSSE (1969), in the present experiment the effect of bucket feeding was found to be more favourable, though not significantly, from the point of view of nutrient conversion (Table 4).

Behaviour studies. While milk was being fed, the length of the milk consumption period for calves fed from nipple-pails (group A) and buckets (group B) was measured for various milk supplement rations, and the speed of milk consumption was calculated from the data. The characteristics thus obtained and the results of analysing them are contained in Table 5.

It generally took the calves longer to consume the milk from nipple-pails than from buckets. However, while in the case of sucking the milk consumption time significantly decreased with age ($r = -0.7438$, $P\% < 0.1$), it hardly changed when feeding milk from buckets ($r = 0.1375$, $P\% > 5$). HOYER—LARKIN (1954) found that the calves required 1—3 minutes to drink 8 pounds (3.63 kg) milk from a bucket, while they consumed the same amount of milk in 12—20 minutes from a nipple with a 1/32 inch (0.79 mm) orifice and in 9—14 minutes

Table 3

Age of calves at the beginning of the experiment, length of rearing periods, trends of live weight and weight gain

Designation	Groups		Statistical significance of differences
	A (sucking)	B (drinking)	
Number of calves	10	10	—
Starting age, days	9.6 ± 1.4	8.5 ± 1.2	n.s.
<i>Length of rearing periods, days</i>			
milk feeding	83.5 ± 2.1	80.9 ± 4.6	n.s.
post-weaning	92.0 ± 0.0	91.0 ± 0.0	n.s.
total	175.5 ± 2.1	171.9 ± 4.6	n.s.
<i>Live weight, kg</i>			
at the beginning	43.9 ± 6.3	39.8 ± 4.4	n.s.
at weaning	111.4 ± 9.2	111.5 ± 5.8	n.s.
at the end of the experiment	216.0 ± 16.5	213.1 ± 10.6	n.s.
<i>Weight gain, kg</i>			
during milk feeding	57.5 ± 5.1	71.7 ± 3.7	*
during post-weaning	104.6 ± 9.5	101.6 ± 7.5	n.s.
altogether	172.1 ± 12.1	173.3 ± 7.4	n.s.
<i>Average daily weight gain, g</i>			
during milk feeding	808.9 ± 66.2	888.3 ± 38.6	*
during post-weaning	1136.8 ± 102.7	1116.6 ± 82.7	n.s.
altogether	980.8 ± 72.0	1008.5 ± 35.7	n.s.

* = $P\% < 5$

n.s. = non-significant

Table 4

Feed conversion

Designation	Groups	
	A (sucking)	B (drinking)
Amount of nutrient used for 1 kg weight gain, kg		
<i>In the milk feeding period</i>		
starch equivalent	2.26	2.23
digestible crude protein	0.597	0.584
<i>In the post-weaning period</i>		
starch equivalent	3.26	3.10
digestible crude protein	0.964	0.947
<i>Average</i>		
starch equivalent	2.86	2.79
digestible crude protein	0.820	0.796

Table 5

Correlations between time and speed of milk intake and age, as well as between speed of milk intake and amount of milk consumed

Groups	Designation				
	n	$\bar{y} \pm s$	$\bar{x} \pm s$	$y = a + bx$	r
<i>Time of milk intake (y), min — age (x), day</i>					
A	370	3.40 ± 1.10	53.09 ± 22.9	$5.31 - 0.0359x$	-0.7438***
B	268	1.30 ± 0.70	38.80 ± 18.5	$1.24 + 0.0014x$	0.1375
<i>Speed of milk intake (y), lit/min — age (x), day</i>					
A	370	1.00 ± 0.28	53.09 ± 22.9	$0.55 + 0.0084x$	0.6717***
B	268	2.50 ± 0.41	38.80 ± 18.5	$2.35 + 0.0038x$	0.1688
<i>Speed of milk intake (y), lit/min — amount of milk (x), lit</i>					
A	370	1.00 ± 0.28	3.11 ± 0.31	$1.14 - 0.0462x$	-0.0498
B	268	2.50 ± 0.41	3.20 ± 0.24	$0.27 + 0.7025x$	0.4018***

group A

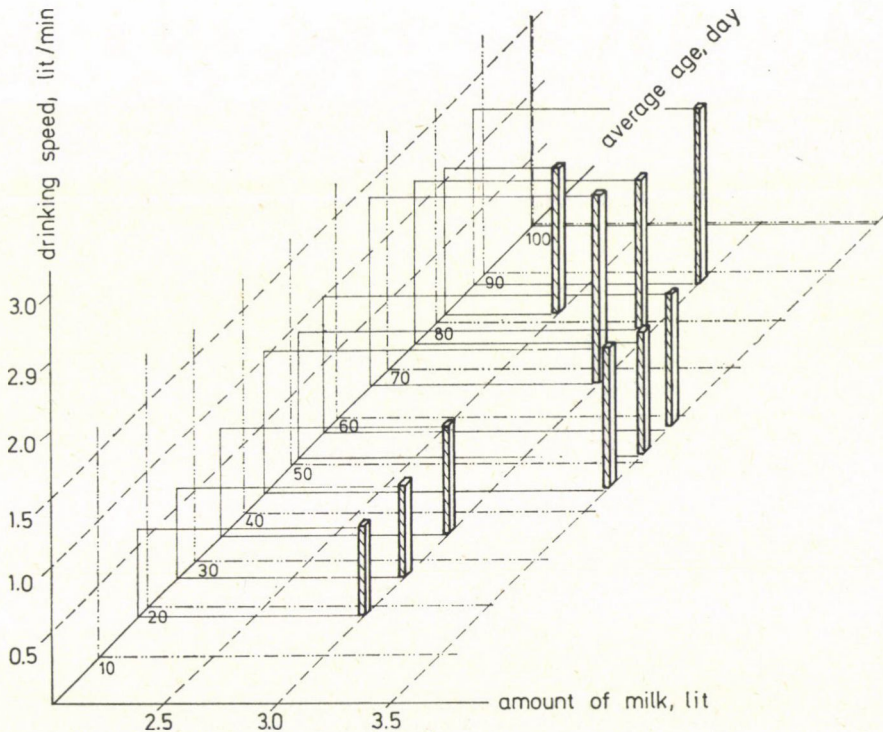


Fig. 1. Speed of milk intake as a function of age and amount of milk in the nipple system of milk feeding

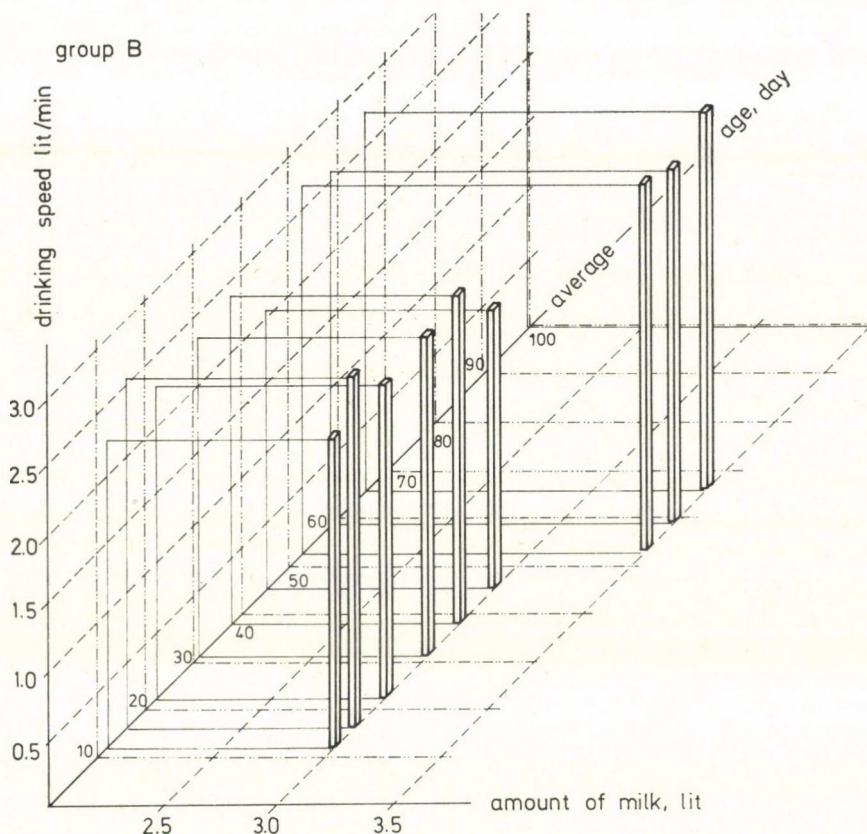
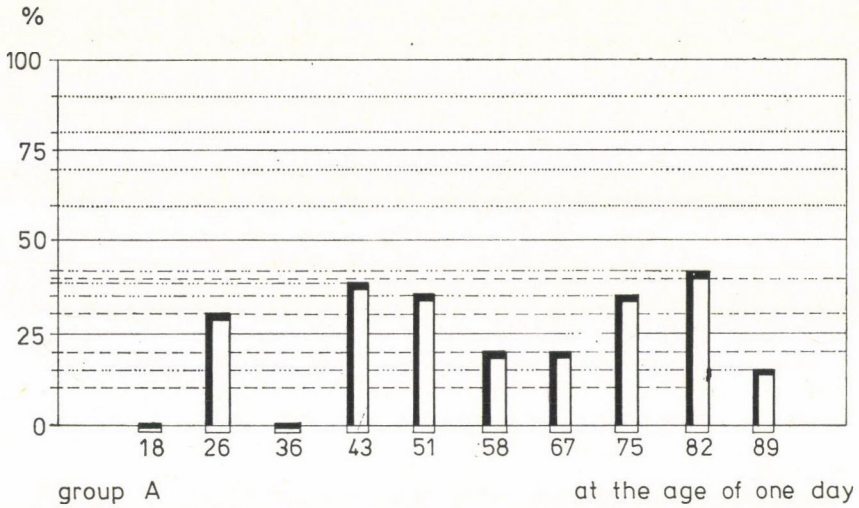


Fig. 2. Speed of milk intake as a function of age and amount of milk in the bucket system of milk feeding

from one with a 1/16 inch (1.59 mm) orifice. According to KESLER *et al.* (1956) the calves consume the same amount of milk in a shorter time from an open bucket than through a nipple. In the experiment carried out by ALEXANDER (1954) the calves consumed their milk rations in 10–12 minutes through a nipple with an orifice of less than 1 mm, and in 1–3 minutes from a bucket. SCHEURMANN (1974a, b) measured 1 to 4-minute periods of milk drinking. In his opinion the situation is quite different when a calf sucks its mother's teats. According to his records a new-born calf may suck as often as eight times a day, while later it seldom does so on more than six occasions, and finally reduces this to a single daily sucking session. Sucking takes an average of 10 minutes at a time; the total daily sucking time ranges from 30.7 to 60.3 minutes. FINGER—BRUMMER (1969) also report on 10-minute sucking periods. KITTNER—KURZ (1967) give an account of 7–8-minute sucking periods, though in some cases sucking was found to last for 17 minutes.

According to the present data the speed of milk consumption when using a nipple-pail (group A) was generally lower than when feeding milk from a bucket (group B). In the case of sucking, on the other hand, the speed of milk consumption significantly increased with age ($r = 0.6717$, $P\% < 0.1$), while with the bucket system it hardly changed ($r = 0.1688$, $P\% > 5$). Figs 1 and 2 show the tendencies described and at the same time call attention to

as a percentage of
all possible cases



as a percentage of
all possible cases

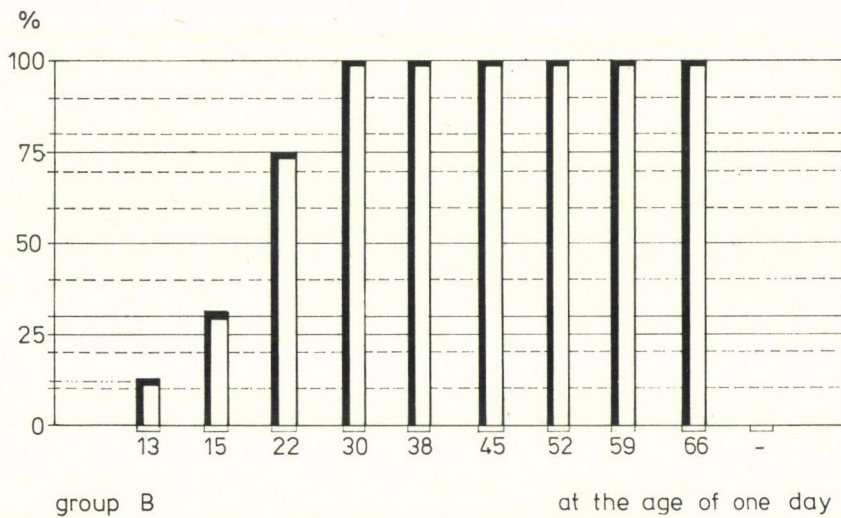


Fig. 3. Proportion of calves inculding in intersucking after milk intake in the case of nipple and bucket feeding, respectively

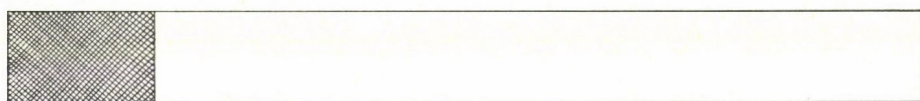
the fact that the speed of milk intake was independent of the amount of milk fed at a time in group A ($r = -0.0498$, $P\% > 5$) and was significantly influenced by it, though only slightly so, in group B ($r = 0.4018$, $P\% < 0.1$). Attention is called by many publications to the fact that the bucket system increases the speed of milk intake compared to the nipple system. According to HAFEZ (1962) the speed of milk consumption increases 4–6-fold when the calves drink from buckets. CZAKÓ (1974a, b) and BALAINE *et al.* (1975) pointed out differences between breeds in the speed of milk consumption. Contrary to the present data, the latter authors found that calves consumed a unit amount of milk at a speed which increased with age even when drinking from buckets. According to the data of ILLÉS (1964a, b) the calves sucked an average of 2 litres milk a minute from the nipple-pail. GERE—GYÖRKÖS (1975), in agreement with our own experience, also observed a shortening of the sucking time with advancing age.

The time and speed of milk consumption measured in the morning and in the afternoon showed occasional differences. Calves in both groups generally took longer to consume the same amount of milk in the morning than in the afternoon; consequently the speed of milk consumption in the afternoon increased compared to the morning (GERE—GYÖRKÖS 1975).

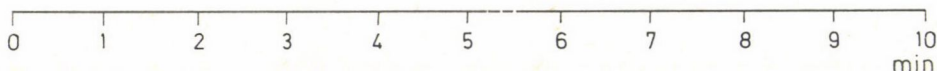
Cross-sucking. According to our observations, the undesirable habit which calves have of sucking various parts of each other's bodies (nose, tongue, ear, plica of neck, navel, scrotum) or various objects (the pen) following milk intake occurred less frequently when milk was fed from nipple-pails than with the bucket system. The relevant data are presented in Fig. 3.

SOUTY (1969) found that calves fed from nipple-pails became accustomed to consuming milk supplements more easily and sucked each other and the surrounding objects less frequently after feeding. SCHEURMANN (1974a, b) considers that the development of cross-sucking is caused by the rapid intake of milk from the bucket, nipple-pail or self-feeder. The rationed amount of milk is consumed and the calf has to stop drinking at the very moment when its innate unconditioned reflex is the strongest. While having consumed a sufficient

milk intake from the udder



milk intake from pail without nipple



sucking



milk
drinking



cross - sucking

Fig. 4. Effect of the way of milk consumption on the feeding activity of calves (SCHEURMANN 1974a, b)

Table 6

*Age, live weight and average daily feed intake of calves
in the behaviour studies*

Designation	Groups		Statistical significance of differences
	A (sucking)	B (drinking)	
Number of calves	10	10	—
Age, day	89.1 \pm 2.6	85.1 \pm 5.4	n.s.
Live weight, kg	105.5 \pm 8.9	99.7 \pm 5.8	n.s.
Daily feed intake			
milk supplement, lit.	6	6	—
fodder, kg	2.02	1.77	—
alfalfa hay, kg	2.17	1.61	—

n.s. = non-significant

amount it has not sucked long enough and tries to find some supplement (Fig. 4). According to Scheurmann's data the number of tucking movements in calves sucking their mothers' udders may vary from 1000 to 2000. The frequency of sucking movements increases until the 4th minute, then decreases. Drinking usually lasts for a much shorter time and takes 1000—1300 movements. Nipple feeding thus corresponds better to the natural sucking behaviour; so it is more sensible to enable the calves to satisfy their needs in a more or less natural way rather than trying to familiarize them with a feeding system unnatural to them. These experimental results are also confirmed by the data of Wood *et al.* (1967), according to whom the habit of sucking each other was twice as frequent among bucket-fed calves as in the group fed through nipples (5—6% in the latter). With an increase in the time required to consume the milk the time spent in idle sucking also decreased ($r = -0.50 - -0.70$) (KITNER—KURZ 1967). GEDDES (1950, 1954) and ALEXANDER (1954) also found that cross-sucking was more frequent when milk was fed from buckets, because, as also stated by HOYER—LARKIN (1954), the sucking stimulus is influenced primarily by the time required for milk consumption.

CZAKÓ (1974a, b) approaches the question from the point of view of individual and group keeping. He considers that calves suck each other because the period of milk consumption is not long enough to satisfy their sucking need rather than because they are kept in groups. STEPHENS (1974b) also regards the unsatisfied natural instinct as responsible for the habit of cross-sucking. Referring to Levy and Ross, who used puppies as experimental subjects, he writes that sucking without feed intake significantly increased when the animals' hunger was quickly satisfied from suckling vessels which supplied the milk at a rapid rate. With calves sucking their mothers, the frequency of cross-sucking was lower. He points out that sucking is necessary to stimulate the delivery of milk and his data confirm the hypothesis that sucking is an outlet for the feeding instinct. However, in his opinion cross-sucking may occasionally be due to unsatisfactory nutrition as well.

The relevant literature suggests various solutions to prevent the habit of cross-sucking. CZAKÓ—ILLÉS (1961) expressed the opinion that since artificially reared calves sucked each other for 15—25 minutes after feeding, prevention should be concentrated on that period. They found a saw-blade attached to the nose-ring to be the most practical mechanical solution, while rubbing the calves with various chemicals proved to be ineffective. Later (CZAKÓ—ILLÉS 1962) they advised tying the animals up for 25 minutes and giving them milk to repl-

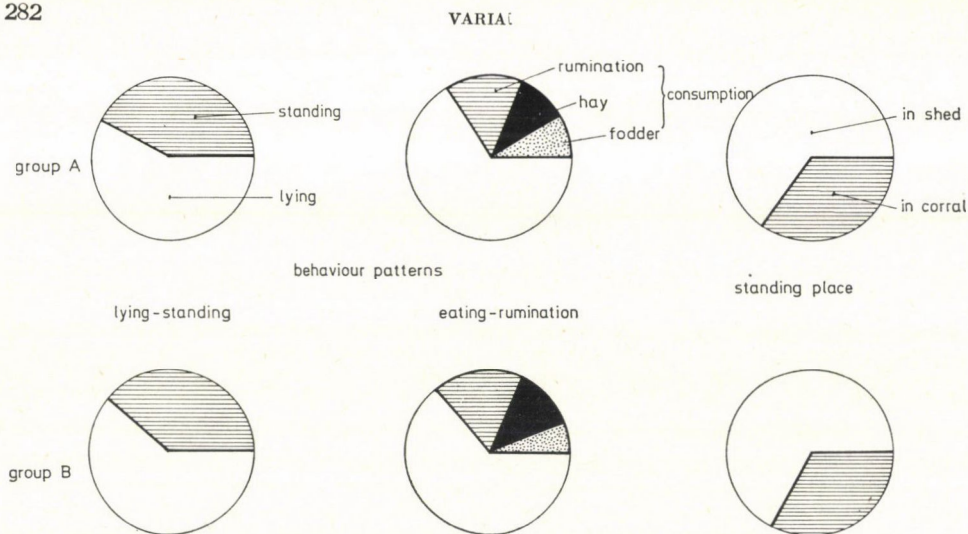


Fig. 5. Values of behaviour responses related to a whole day (24 hours) ($360^\circ = 100\%$)

tion. Besides also suggesting tying up the calves after feeding milk, ILLÉS (1964a, b) and KITTNER—KURZ (1967) advise the separation of animals initiating cross-sucking. According to KITTNER—KURZ (1967), MOLNÁR (1974), MUSZÉLY (1965) and ILLÉS (1964a) the calves should either be fed with milk to repletion or be given fodder after drinking milk. In earlier investigations (SZÜCS 1971) it was found that although the habit of cross-sucking decreased somewhat in calves fed from a self-feeder with larger amounts of milk supplement at a moderate concentration, the problem was not finally solved even by leaving the calves to drink to repletion. On the basis of experiments carried out with nurse-cows MOLNÁR (1974) considers it practical to feed roughage following an appropriate sucking period. DINU (1972) constructed a suckling apparatus supplying the milk in small doses. The unnatural and rapid consumption of milk resulting from artificial feeding can thus be avoided, together with the digestion disorders involved. The prolongation of sucking so as to bring it close to the natural sucking time is recommended by HOYER—LARKIN (1954). They think it feasible by narrowing the orifice of the nipple. GEDDES (1950) also suggests the use of an insertion with a small nipple opening. In the present experiments, with the prolongation of the sucking time the calves gradually abandoned the habit of intersucking.

Daily periods of lying down, feed intake and rumination, frequency of drinking, and choice of standing place. In the course of behaviour studies carried out before weaning at nearly identical live weights and ages the calves consumed the same amount of milk supplement and nearly the same quantity of solid feed (Table 6), though those in group B (fed milk from buckets) consumed somewhat less grain and hay than the nipple-fed calves (group A).

According to the etograms, which refer to a 24-hour daily period, the relative percentage values of the behaviour responses (Fig. 5) did not vary significantly as a result of the different systems of feeding milk, and are close to those obtained in earlier investigations (CZAKÓ 1974a, b, SZÜCS *et al.* 1975a, b). Since the present investigations were made in summer the calves spent much of their time in the corrals.

*

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INHERITANCE OF HEADING DATE IN STEM RUST RESISTANT WHEAT VARIETIES, AND DISEASE ESCAPE

Stem rust epidemics causing considerable losses in the grain yield of wheat have not occurred in Hungary for a long time. Although moderate epidemics developed in the seventies (MANNINGER *et al.* 1978), they did not cause such great damage as the 1932 epidemic (LELLEY—RAJHÁTHY 1955), which resulted in serious losses of yield. A new epidemic could possibly be caused by various circumstances. One of the greatest dangers could be the appearance of new rust races in addition to the 3—5 races prevalent in recent years (BÓCSA 1980, verbal information), which would change the race composition so much that the present horizontal and vertical resistance would no longer give protection from the pathogen.

Several methods for preventing this danger have been elaborated, though a completely satisfactory solution has not been found anywhere so far. In the countries which are most exposed to stem rust epidemics, for example, attempts have been made to solve the problem by breeding multiline varieties (PARLEVLIET 1979). Another possible solution is to select genotypes possessing horizontal resistance (MATUZ *et al.* 1979) and tolerance to stem rust, in which the infection develops slowly and results in negligible losses of grain yield.

In certain cases disease escape may also be a means of preventing stem rust epidemics. In Hungary the probability of stem rust damage can be reduced by selection for earliness (RAJKI 1961), since in such cases the pathogen appears too late to be able to decrease the grain yield.

Taking this into consideration an attempt was made to determine whether an epidemic developing in the case of a supposed change in the stem rust race composition could be controlled with the help of the disease escape mechanism when genetically based resistance no longer gave protection.

The experiment was laid out in autumn 1978 in the wheat trial grounds of the Agricultural Research Institute of the Hungarian Academy of Sciences, Martonvásár, in a random block design with four replications, at a spacing of 10×10 cm.

Two generations (F_1 and F_2) were simultaneously studied in a half-diallel experiment with 6 parents. Three of the parents (Arthur, Zg 884/73 and Kavkaz) were resistant, and the other three (GT 13A, Ogosta and Jubileinaya 50) were susceptible to stem rust. Ten plants per replication were evaluated in the F_1 treatment and 30 in the F_2 treatment.

In the course of the vegetation period the heading date, characterized by the appearance of the main spike, was recorded for each plant. In the calculations the heading date was expressed as the number of days from 1st May until the appearance of the main spike.

The difference in heading date between the crossing partners and their hybrids was demonstrated by analysis of variance. The heterosis effect (H) was determined on the basis of deviation from the average of the two parents.

General and specific combining ability for both generations examined were determined using the method described by KEULS—GARRETSEN (1977), which agrees in essentials with GRIFFING's (1956) analysis. The calculations were carried out with an HP 9831 A type computer.

Table 1

Heading date and heterosis effect in the parents and hybrids examined

	Parents and F ₁		F ₂	
	heading date days from 1st May	heterosis effect	heading date days from 1st May	heterosis effect
GT 13A	22.95			
Zg 884/73	29.43			
Ogosta	26.60			
Jubileinaya 50	27.33			
Arthur	25.93			
Kavkaz	31.65			
GT 13A × Zg 884/73	27.53	5.12	27.01	3.13
GT 13A × Ogosta	25.40	2.52	25.80	4.14
GT 13A × Jubileinaya 50	25.30	0.64	25.72	2.31
GT 13A × Arthur	23.48	-3.93	24.50	0.25
GT 13A × Kavkaz	26.30	-3.66	26.92	-1.39
Zg 884/73 × Ogosta	28.08	0.23	29.65	5.84
Zg 884/73 × Jubileinaya 50	28.08	-1.06	27.78	2.11
Zg 884/73 × Arthur	27.00	-2.46	27.41	-0.98
Zg 884/73 × Kavkaz	30.20	-1.11	29.87	-2.19
Ogosta × Jubileinaya 50	27.15	0.69	28.46	6.21
Ogosta × Arthur	25.15	-4.25	26.36	0.36
Ogosta × Kavkaz	27.78	-4.62	28.48	-2.21
Jubileinaya 50 × Arthur	25.28	-5.07	25.70	-3.49
Jubileinaya 50 × Kavkaz	28.70	-2.68	27.21	-7.73
Arthur × Kavkaz	26.93	-6.46	27.40	-4.83
LSD _{5%}	0.48		1.39	
LSD _{1%}	0.64		1.85	
LSD _{0.1%}	0.82		2.40	

It should be noted that the experiment was also analysed with the diallel method given by HAYMAN (1954). The results could not be evaluated, however, because the correlation between the parents and the values of covariance + variance ($W + V$) was not significant, although no demonstrable epistasis effect was obtained and the regression standard deviation (s_b) of the fitted line also proved negligible.

Of the parents used as sources of stem rust resistance, Arthur and Zg 884/73 can be placed in the medium early group, while Kavkaz is a late variety. Of the varieties susceptible to stem rust, GT 13 A is very early, while Ogosta and Jubileinaya 50 are medium early. The heading dates for the varieties and for generations F₁ and F₂, and the values of the heterosis effect, are contained in Table 1.

From the point of view of earliness, and thus of disease escape, the negative heterosis effect is favourable for breeding. The highest negative value was displaced by the combination Arthur \times Kavkaz. This feature was dominant in both generations. These two varieties gave similar results in other combinations as well, for instance in GT 13A \times Kavkaz, Jubileinaya 50 \times Arthur, Zg 884/73 \times Arthur, Ogosta \times Kavkaz, Zg 884/73 \times Kavkaz and Jubileinaya 50 \times Kavkaz. On the other hand, for traditional wheat breeding it is a disadvantage that the negative H-values obtained in the F_1 generations of Ogosta \times Arthur, GT 13A \times Arthur and Zg 884/73 \times Jubileinaya 50 were not verified in the F_2 generations. Therefore, in carrying out selection in the F_2 , only a smaller proportion of early genotypes can be expected.

The variance of the general (GCA) and specific (SCA) combining ability was determined for the two generations examined (Table 2). It was found that the variance of the general combining ability in both generations and the variance of the specific combining ability in the F_1 were significant at the 0.1% level of probability, while the specific combining ability of the F_2 was not significant. JATASRA—PARODA (1978) obtained similar results when studying the F_2 generation.

On the basis of the ratio of GCA-SCA variances it can be established that, owing to the considerable proportion of GCA, additive gene effects are dominant in the transmission of heading date in both generations.

Table 2
Mean squares of the two generations examined

Generation	MQ value		Error	GCA : SCA
	general	specific		
	combining	ability		
F_1	23.45***	0.664***	0.114	35.3 : 1
F_2	18.60***	1.009 ^{NS}	0.968	18.4 : 1

*** $P = 0.1\%$

NS = non-significant

Table 3
General combining ability in the parents

Parents	F_1	F_2
Arthur	-1.277	-1.029
Zg 884/73	1.481	1.295
Kavkaz	1.688	1.335
GT 13A	-1.746	-1.764
Jubileinaya 50	0.067	-0.155
Ogosta	-0.212	0.318
Standard error	0.089	0.259

Table 4
*Specific combining ability (SCA) of hybrids
 in the F_1 and F_2 generations*

Combination	F_1	F_2
GT 13A \times Zg 884/73	0.89	0.29
GT 13A \times Ogosta	0.45	-0.07
GT 13A \times Jubileinaya 50	0.07	0.42
GT 13A \times Arthur	-0.40	0.10
GT 13A \times Kavkaz	-0.55	0.02
Zg 884/73 \times Ogosta	-0.09	0.76
Zg 884/73 \times Jubileinaya 50	-0.37	-0.50
Zg 884/73 \times Arthur	-0.11	-0.18
Zg 884/73 \times Kavkaz	0.13	0.02
Ogosta \times Jubileinaya 50	0.39	1.23
Ogosta \times Arthur	-0.27	-0.19
Ogosta \times Kavkaz	-0.60	-0.48
Jubileinaya 50 \times Arthur	-0.42	-0.37
Jubileinaya 50 \times Kavkaz	0.04	-1.19
Arthur \times Kavkaz	-0.39	-0.12
Standard error	0.20	0.26

The general combining ability of the parents (Table 3) showed the same trend in both generations. Among the stem rust resistant varieties Arthur proved the best from the point of view of breeding for earliness, while GT 13A was the best of the susceptible varieties. On the other hand, Kavkaz, a variety with a favourable heterosis effect, came last.

Table 4 shows the specific combining abilities of the hybrids. When specific combining ability and heterosis effect are taken into consideration the combinations Zg 884/73 \times Arthur, Ogosta \times Kavkaz, Jubileinaya 50 \times Arthur and Arthur \times Kavkaz form a separate group, where the favourable heterosis effect may have been caused by additive gene effects. GT 13A \times Kavkaz, a combination with negative SCA in the F_1 generation, can also be placed in this group. On the other hand, the combination Jubileinaya 50 \times Kavkaz has a negative SCA value in the F_2 generation. Zg 884/73 \times Kavkaz is the only combination where the favourable heterosis effect is coupled with a positive SCA value. Thus, the heterosis effect must have been determined by gene effects of non-additive character, i.e. by dominance and epistasis.

The results prove the possibility of choosing a source of stem rust resistance which causes disease escape, i.e. earliness, and can be used for breeding purposes. This statement is supported by the line Mv 2-24-78 produced at the Martonvásár institute by crossing Arthur with Moisson. This experimental line is earlier than either of its parents, and in the national trial of early varieties and experimentals organized by the National Agricultural Variety Testing Institute in 1978/79 it occupied the third place on the basis of grain yield. In addition, it is resistant to stem rust and powdery mildew. Arthur showed the highest general combining ability in the present experiment, too, and the Arthur hybrids were found to have a good heterosis effect and low specific combining ability. All these properties increase its value in breeding for earliness.

Of the varieties examined Kavkaz has the longest vegetation period, but there is a greater probability of selecting early genotypes from hybrids of Kavkaz with earlier varieties than from among the progeny of Zg 884/73.

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HISTOLOGICAL CHANGES IN THE LEAF OF SUNFLOWER (*HELIANTHUS ANNUUS* L.) IN RESPONSE TO 2,4-D TREATMENTS

Hormone-based herbicides cause deformations in both the aboveground and the belowground parts of plants. In the aboveground parts shoot deformation and the twisting or fasciation of the stems occur. The leaves may become funnel-shaped (BUHL 1958, UBRIZSY 1962) or form a tubular accretion (WAY 1964, Kiermayer cit. AUDUS 1964); the leaves of the grape-vine show deformations resembling nettles or *Ginkgo* leaves (UBRIZSY 1962, SZATALA 1967) and other morphological changes (Andersen, Bachthaller, Fiedler, Hanf cit. UBRIZSY 1962, TERPÓ-POMOGYI—TERPÓ 1971). Serious distortions appear on the fruit (UBRIZSY 1962). The root may also be considerably damaged (WAY 1963). UBRIZSY (1962) mentions the high sensitivity of sunflower and tobacco.

The external changes in plants are the results of damage done by hormone-based herbicides to the plant tissues (AUDUS 1964). The toxic effect of these herbicides is based on the fact that they do not decompose in the plant tissues but remain active for a long time (UBRIZSY 1962). Substantial damage occurs in the leaves during cell differentiation; the leaf will not be greatly injured if it is fully, or almost fully developed at the time of the treatment (WATSON 1948). Treatments with hormone-based herbicides result in an over-reproduction of cells in the meristem and the vascular phloem elements of the stem (EAMES 1951); the develop-

ment of the cell-wall is also greatly influenced by these herbicides (Gorter, Gifford cit. AUDUS 1964). The palisade parenchyma cells enlarge in all directions, but mainly longitudinally (WATSON 1948). Haccius (cit. AUDUS 1964) observed deformation in the spongy parenchyma cells. The leaf veins on the abaxial surface become conspicuously protuberant as a result of treatments with 2,4-D (FELBER 1948, WATSON 1948). In the leaf the vascular bundles are close to each other (EAMES 1949, WATSON 1948).

An experiment was set up by the author using sunflower plants (variety: VNIIMK 6541). Sowing was carried out on 12th May 1978, and the plants were treated at the 12 cm stage of development, on 12th June.

The herbicide used in the treatment was Dikonirt D, which contains 2,4-D amine as active agent. The herbicide was applied in the form of a spray. The treatments were: 145 ppm Dikonirt D; 1450 ppm Dikonirt D; 7250 ppm Dikonirt D; untreated control.

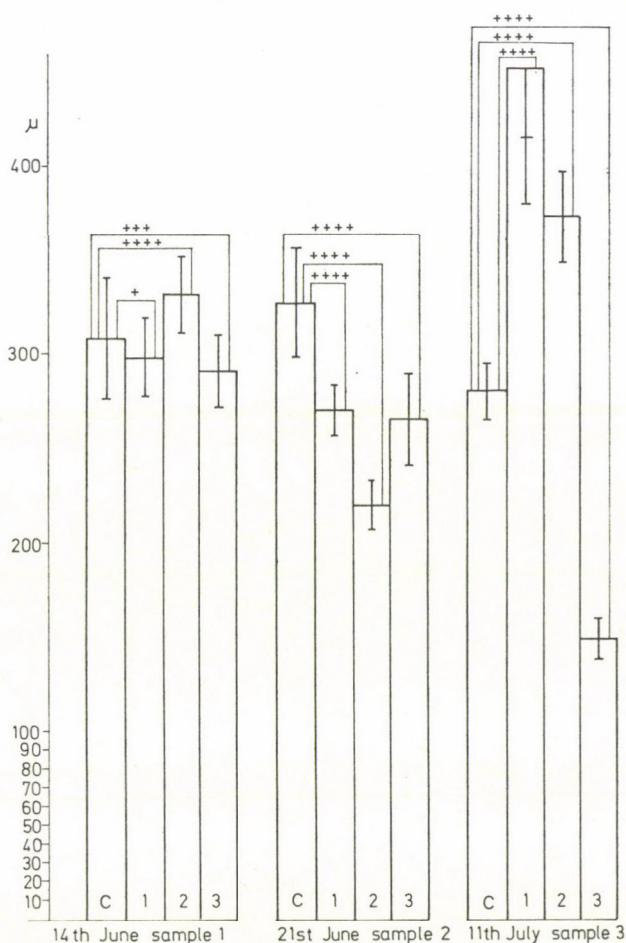


Fig. 1. Changes in the leaf thickness as a result of treatment with 2,4-D (+ = $p < 5\%$, ++ = $p < 2\%$, +++ = $p < 1\%$, ++++ = $p < 0.1\%$; c = control, 1 = 145 ppm, 2 = 1450 ppm, 3 = 7250 ppm)

Three plants were treated with each concentration of the herbicide, one of which was marked for sampling. Samples were taken on three occasions: 1st sampling: 14th June, 2nd sampling: 21st June, 3rd sampling: 11th July.

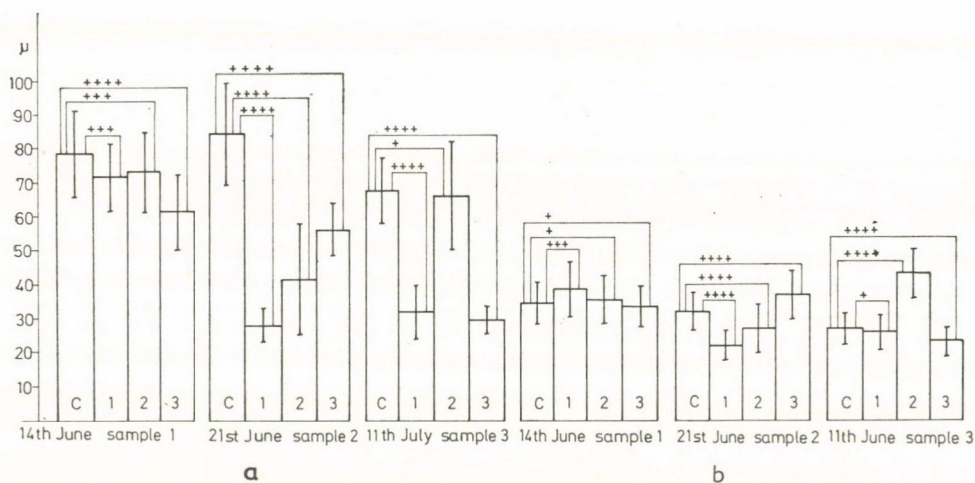


Fig. 2. a) Changes in the length of palisade parenchyma cells as a result of treatment with 2,4-D; b) Changes in the length of spongy parenchyma cells as a result of treatment with 2,4-D (+ = $p < 5\%$, ++ = $p < 2\%$, +++ = $p < 1\%$, ++++ = $p < 0.1\%$; c = control, 1 = 145 ppm, 2 = 1450 ppm, 3 = 7250 ppm)

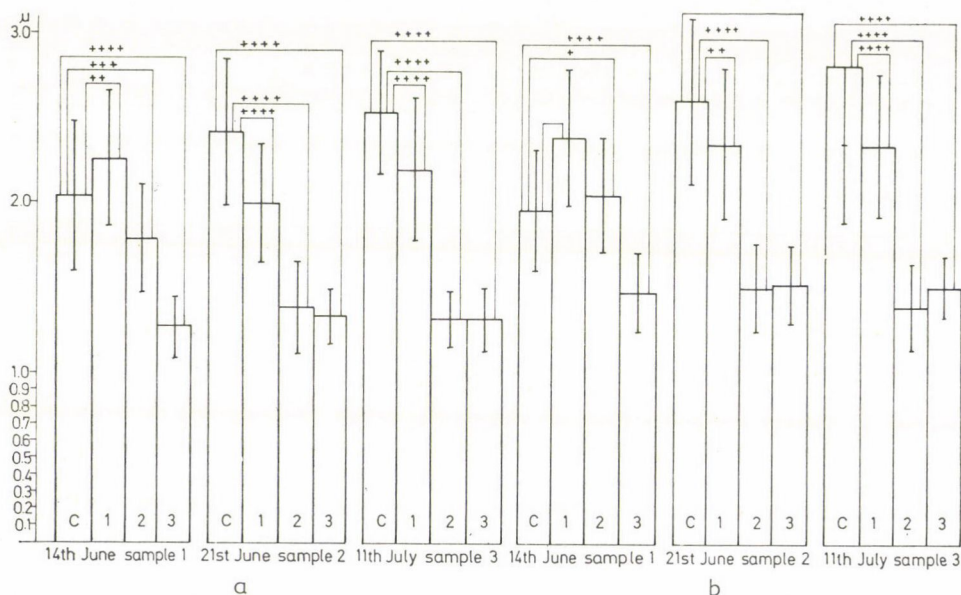


Fig. 3. a) Changes in the wall thickness of epidermis cells on the adaxial surface of the leaf; b) Changes in the wall thickness of epidermis cells on the abaxial leaf surface in response to treatment with 2,4-D (+ = $p < 5\%$, ++ = $p < 2\%$, +++ = $p < 1\%$, ++++ = $p < 0.1\%$; c = control, 1 = 145 ppm, 2 = 1450 ppm, 3 = 7250 ppm)

The samples were taken in the morning, and fixed in 40% alcohol. The sections were prepared from the middle of the leaf by means of a slide microtome furnished with a KTOC-2 electring freezing appliance. The sections were stained with Ehrlich's acidic haematoxylin. When evaluating the experiment the thickness of the leaf, the thickness of the epidermis cell-walls on the adaxial and abaxial leaf surfaces, and the lengths of the palisade and spongy parenchyma cells were measured. Considering that the spongy parenchyma cells are generally of irregular shape, the distance between the two extreme points was measured when determining the length. The data obtained were evaluated by the double t-test; the results of the evaluation are shown in Figs 1—3. The figures depict the histological changes which have taken place in the leaves of control and treated plants in the case of three different concentrations in samples taken at three successive dates.

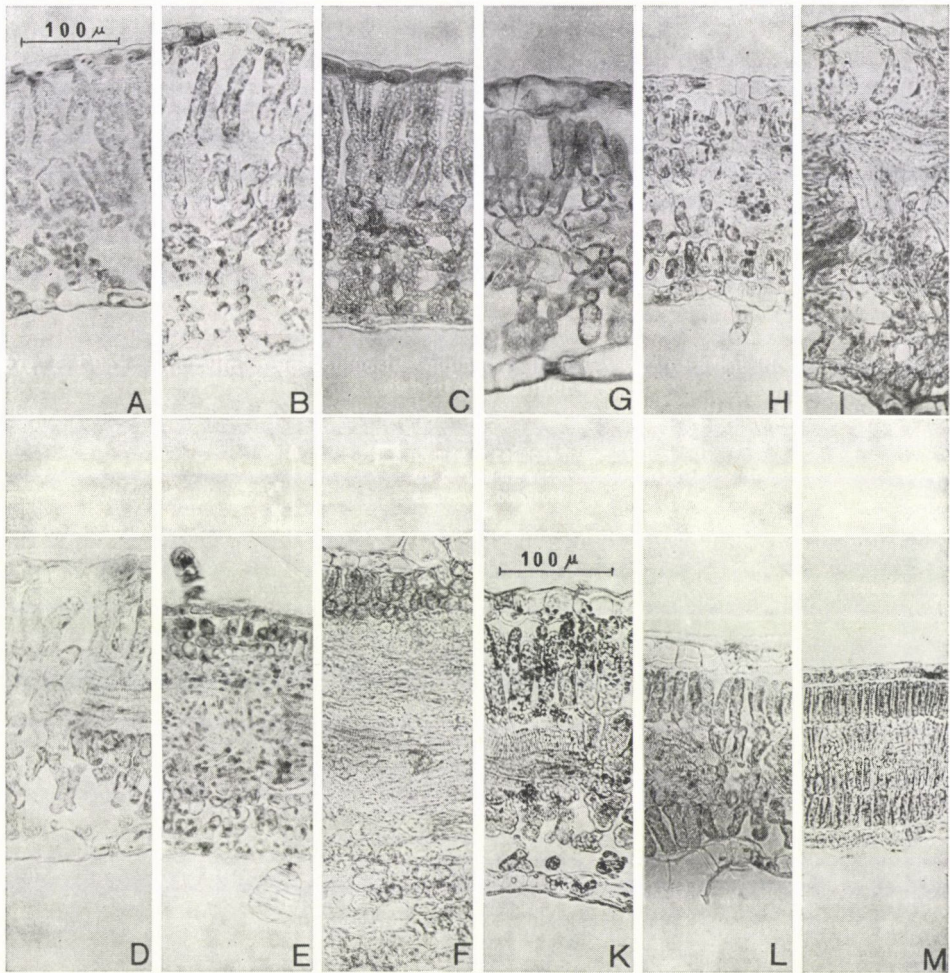


Fig. 4. Cross-sections of leaves in the control, and from plants treated with 2,4-D (A—D = control, D—F = 145 ppm, G—I = 1450 ppm, K—M = 7250 ppm Dikonirt D; A, D, G, K = Sample 1 (14th June); B, E, H, L = Sample 2 (21st June); C, F, I, M = Sample 3 (11th July); (Figs A, B, C, D, E, F, G, H, I and L are on the same scale, as are Figs K and M)

Examination of control leaves

Sample 1 (taken on 14th June). The leaf has a bifacial structure (Fig. 4A); stomata are found both in the adaxial and abaxial epidermis. The palisade parenchyma is 2 cell-rows wide, and consists of elongated cells which are not tightly closed (Fig. 5A), the length of which is 2—3 times the width. The spongy parenchyma consists of 2—3 rows of loosely arranged, irregularly shaped cells (Fig. 5G). The vascular bundles are placed in the leaves at some distance from one another — $113\ \mu$ on average ($88\text{--}139\ \mu$); the protrusion of the leaf over the major veins is slight. The thickness of the leaf is even, the adaxial and abaxial epidermises are free from protuberances and depressions.

Sample 2 (taken on 21st June). The palisade and spongy parenchyma cells and the vascular bundles are arranged similarly to those in Sample 1 (Fig. 4B). The palisade parenchyma is 2 cell-rows and the spongy parenchyma 2—3 cell-rows wide (Fig. 5H). The palisade parenchyma cells are somewhat elongated (Fig. 5B), the length being 3—4 times the width. The vascular bundles are at an average distance of $119\ \mu$ ($98\text{--}140\ \mu$) from one another. The thickness of the leaf is uniform; the upper and lower epidermises are similar to those in Sample 1.

Sample 3 (taken on 11th July). The cells of the palisade and spongy parenchyma (Fig. 4C), as well as the vascular bundles, are placed in the same way as in Sample 1. The distance between the vascular bundles is $107\ \mu$ on average ($82\text{--}132\ \mu$). The palisade parenchyma cells (Fig. 5C) are arranged in 2 rows, and those of the spongy parenchyma (Fig. 5I) in 2—3 rows. The palisade parenchyma cells are considerably elongated; their length is some 4—5 times their width. The thickness of the leaf is uniform; the adaxial and abaxial epidermises are similar to those in Sample 1.

Examination of herbicide-treated leaves

Effect of 145 ppm Dikonirt D

Sample 1 (taken on 14th June). The palisade parenchyma cells (Fig. 5D) are arranged in 1—2 rows (Fig. 4D). Cells towards the middle of the leaf are shorter than those below the epidermis. Cells towards the epidermis are 3—4 times longer than they are wide, while those towards the median plane have a length 2—3 times their width. The cells are not tightly set. The spongy parenchyma cells (Fig. 5K), mostly of irregular shape, are arranged in 2 rows (Fig. 4D). There is a slight change of shape: namely, some cells have become elongated and are morphologically similar to the palisade parenchyma cells. The cells of the spongy parenchyma are loosely arranged. The vascular bundles have come considerably closer to one another compared to those in the control. The distance between them is $50\ \mu$ on average ($46\text{--}54\ \mu$). The thickness of the leaf is uniform, the epidermis both on the upper and lower surfaces is free from protuberances and depressions. The leaf differs from the control only slightly as regards thickness (Fig. 1), but a substantial difference was found in the length of the palisade and spongy parenchyma cells (Fig. 2). The thickness of the epidermis cell-walls (Fig. 3) is considerable on both the adaxial and abaxial leaf surfaces.

Sample 2 (taken on 21st June). The palisade parenchyma is 1—2 cell-rows wide; the cells are not tightly set. They are mostly longish (Fig. 5E), though there are many short, square or round cells. They are considerably smaller in size, their length being at most twice their width. The spongy parenchyma is 2 cell-rows wide, with the cells set more tightly compared to the control and to Sample 1 of the 145 ppm treatment. The cells are roundish or square (Fig. 5L), sometimes longish (the latter are 2—3 times longer than they are wide). The vascular bundles between the palisade and spongy parenchyma layers are very close to each other (Fig. 4E). The vascular bundles occupy about half the thickness of the leaf. The leaf

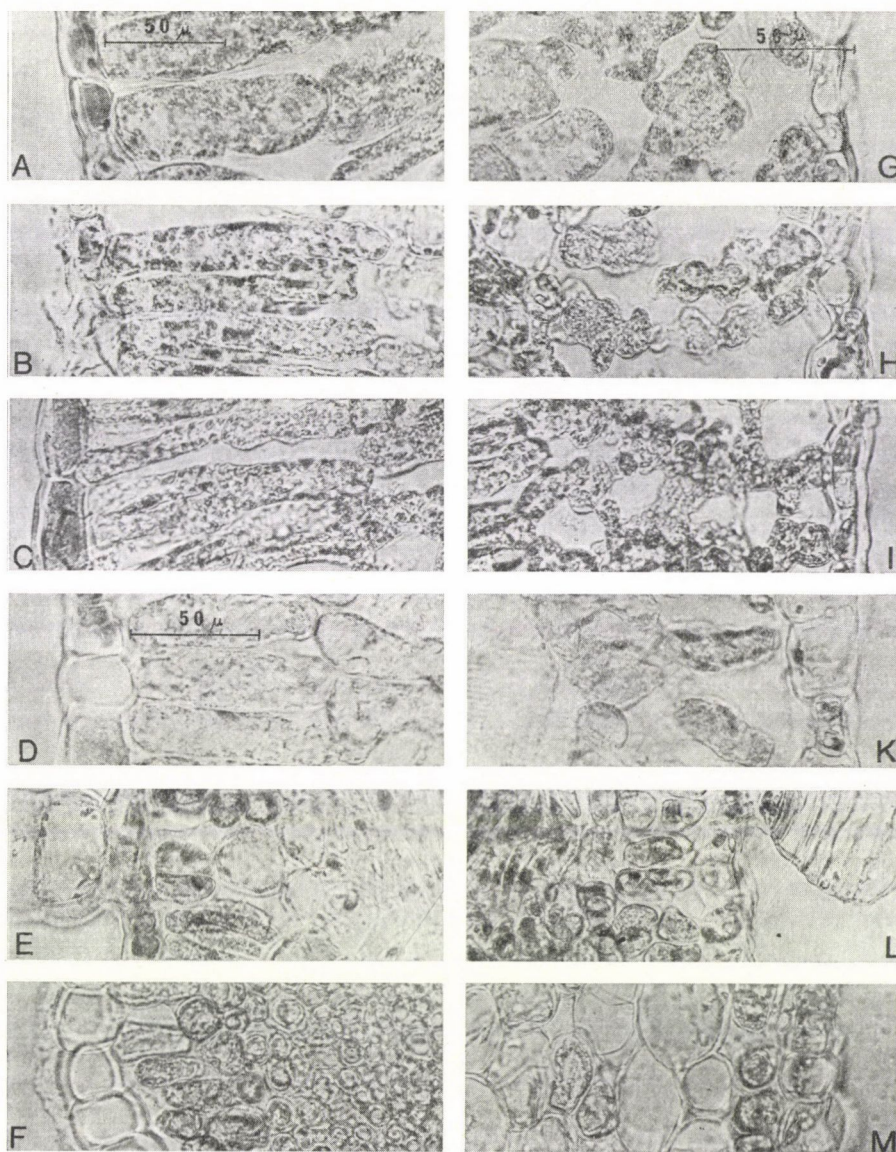


Fig. 5. Changes in the palisade and spongy parenchyma cells in the leaves of control and 2,4-D treated plants according to treatments [A—F = palisade parenchyma cells; A—C = control, D—F = 145 ppm Dikonirt D; G—M = spongy parenchyma cells; G—I = control, K—M = 145 ppm Dikonirt D; A, D, G, K = Sample 1 (14th June); B, E, H, L = Sample 2 (21st June); C, F, I, M = Sample 3 (11th July); Figs A, B, C, E, F, H, I, K, L and M are on the same scale, as are Figs D and G]

epidermis undulates conspicuously on the lower surface, but less so on the upper surface; the larger leaf veins on the abaxial leaf surface protrude sharply.

The thickness of the leaf compared to the control (Fig. 1) is greatly reduced; this reduction is also characteristic of the length of the cells in the palisade and spongy parenchyma (Fig. 2). The epidermis cell-walls are found to have become considerably thinner (Fig. 3) on both sides of the leaf.

Sample 3 (taken on 11th July). The palisade parenchyma is 2 cell-rows wide: the cells are not closely set. The cells are longish, roundish or irregular in shape (Fig. 5F), but in all cases they are stumpy, and even the longish cells are at most twice as long as they are wide. The spongy parenchyma is 4—5 cell-rows wide, consisting of short, roundish or oblong cells (Fig. 5M) arranged in tight rows as in the palisade parenchyma. The longish cells are at most twice as long as they are wide. The vascular bundles, which run closely side by side between the palisade and spongy parenchyma layers, occupy about half the thickness of the leaf. The epidermis is strongly undulated on the upper and lower leaf surfaces alike; the larger veins on the lower leaf surface protrude sharply.

In comparison to the control and the previous samples the leaf is considerably thickened (Figs 1, 4F); the length of the palisade parenchyma cells (Fig. 2) shows a substantial reduction, while that of the spongy parenchyma cells (Fig. 2) only decreases slightly. The thickness of the epidermis cell-walls (Fig. 3) is greatly reduced on both sides of the leaf.

Effect of 1450 ppm Dikonirt D

Sample 1 (taken on 14th June). The cells of the palisade parenchyma are arranged in 1—2 rows which are not set too closely. They are longish (Fig. 6A), their length being 3—4 times their width. The spongy parenchyma is 2 cell-rows wide, with stumpy cells, some of which are irregular, and some roundish (Fig. 6G). Many cells are longish, like those of the palisade parenchyma, but their length is at most twice their width. The longish cells are arranged similarly to the cells of the palisade parenchyma. The vascular bundles are closer to each other than in the control leaves; the distance between them is $53\ \mu$ on average (48 — $58\ \mu$). The thickness of the leaf is relatively uniform. There are neither protuberances, nor depressions on the upper leaf epidermis, while the lower epidermis is slightly undulated. The leaf veins protrude considerably. The leaf is appreciably thickened (Figs 1, 4G) compared to the control; the length of the palisade parenchyma cells (Fig. 2) is considerably reduced, while the spongy parenchyma cells show only a very slight difference in length compared to the control (Fig. 2). The thickness of the epidermis cell-walls is greatly reduced on the upper surface, and only slightly so on the lower surface of the leaf compared to the control (Fig. 3).

Sample 2 (taken on 21st June). The palisade parenchyma is 1—2 cell-rows wide (Fig. 6B). The cells, which are not closely arranged, are longish with a length 3—4 times their width; cells towards the median plane are shorter, being at most 3 times as long as they are wide.

The spongy parenchyma is 2—3 cell-rows wide. The cells have completely lost the shape found in the control, some of them being longish but stumpy, others roundish, and they are arranged in a manner similar to that shown by the cells of the palisade parenchyma (Fig. 6H). The length of the cells is at most twice their width. The vascular bundles are much closer to one another than in the first sample; the distance between them is $28\ \mu$ on average (24 — $32\ \mu$). The adaxial leaf epidermis is flat, but the abaxial one is slightly undulated and the veins here protrude to a great extent. The thickness of the leaf is comparatively even, but has been greatly reduced (Figs 1, 4H). There is a similar reduction in the length of the palisade parenchyma cells in particular (Fig. 2), while the length of the spongy parenchyma cells has decreased to a lesser extent. The thickness of the epidermis cell-walls (Fig. 3) is greatly reduced on both sides of the leaf.

Sample 3 (taken on 11th July). The cells of the palisade parenchyma (Fig. 6C) are arranged in a single row, which is not tightly set; they are longish, being 2—3 times longer than they are wide. The cells of the spongy parenchyma (Fig. 6I) form a layer of 1—2 cell-rows; similarly to the palisade parenchyma cells they are not closely set, though they are

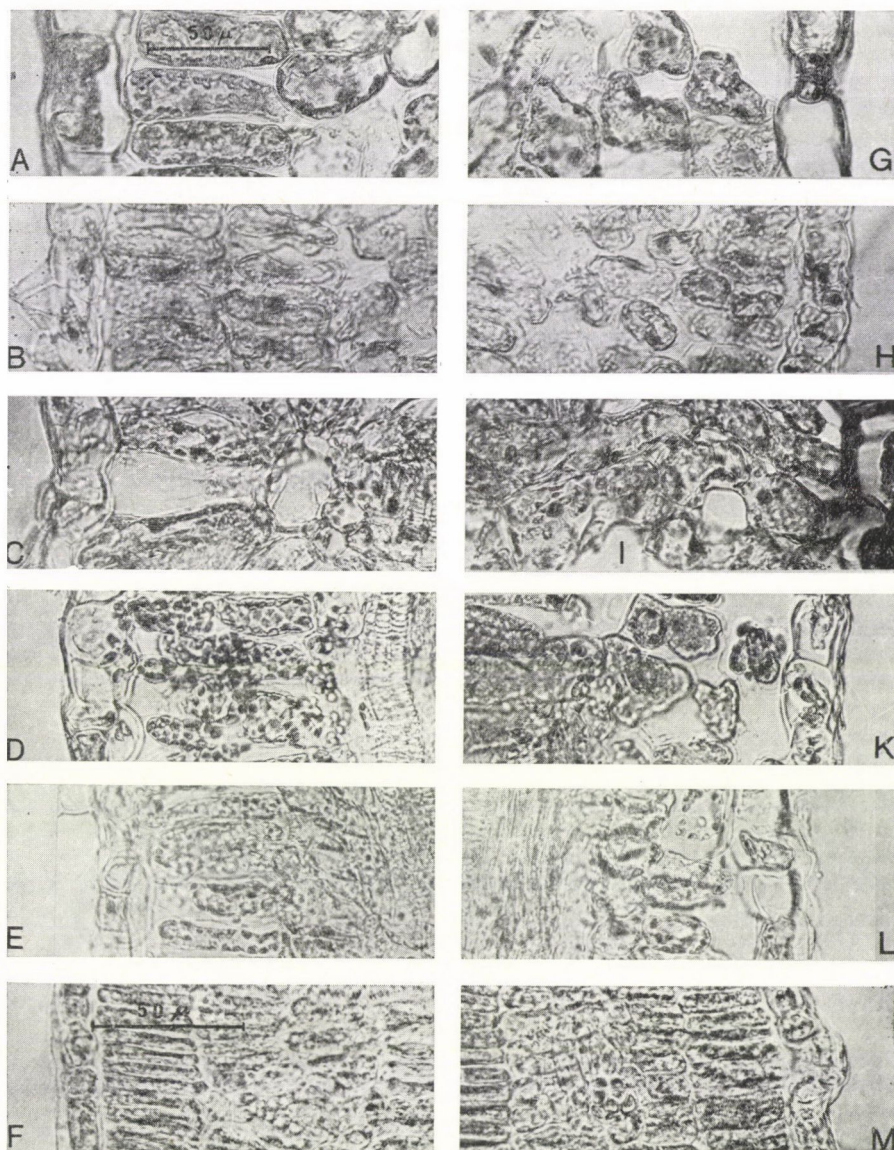


Fig. 6. Changes in the palisade and spongy parenchyma cells as a result of treatment with 2,4-D [A—F = palisade parenchyma cells; A—C = 1450 ppm, D—F = 7250 ppm Dikonirt D; G—M = spongy parenchyma cells; G—I = 1450 ppm, K—M = 7250 ppm Dikonirt D; A, D, G, K = Sample 1 (14th June); B, E, H, L = Sample 2 (21st June); C, F, I, M = Sample 3 (11th July); Figs A, B, C, D, E, G, H, I, K and L are on the same scale, as are Figs F and M]

much closer than the cells of the control. They are partly longish, and partly roundish or of irregular shape. The longish cells are 2—3 times longer than they are wide.

The vascular bundles run close to one another, at an average distance of $27\ \mu$ (21 — $33\ \mu$), and occupy more than a third of the thickness of the leaf. The epidermis is slightly undulated on the upper surface, and more so on the lower surface of the leaf. The thickness of the leaf is uneven. The protrusion of the leaf veins, which is appreciable even on the adaxial surface, is of very great extent on the abaxial surface. The leaf is considerably thickened compared to the previous samples and the control (Figs 1, 4I); as to their length, the palisade parenchyma cells differ only slightly from the control, while the spongy parenchyma cells differ substantially (Fig. 2). The thickness of the epidermis cell-walls is considerably reduced compared to the control (Fig. 3).

Effect of 7250 ppm Dikonirt D

Sample 1 (taken on 14th June). The cells of the palisade parenchyma (Fig. 6D) form a layer of 1 or 2 rows, not tightly arranged. They are longish, though those towards the median plane of the leaf are somewhat stumpier. The length of the cells is 2—3 times their width. The spongy parenchyma is 1—2 cell-rows wide, consisting of irregularly shaped, round, or longish stumpy cells. The arrangement of the cells in the rows is looser (Fig. 6K) than in the palisade parenchyma. The longish cells are at most twice as long as they are wide. The palisade and spongy parenchyma layers are arranged in the same way as in the control (Fig. 4K).

The vascular bundles are close to one another; the distance between them is $62\ \mu$ on average (55 — $68\ \mu$). The adaxial and abaxial leaf epidermises show no undulation; the protrusion of the leaf veins on the abaxial surface is insignificant. The thickness of the leaf is relatively uniform. The thickness of the leaf is somewhat reduced (Fig. 1); the length of the palisade parenchyma cells is greatly reduced and that of the spongy parenchyma cells very slightly so compared to the control (Fig. 2). The thickness of the epidermis cell-walls shows a sharp reduction on both sides of the leaf (Fig. 3).

Sample 2 (taken on 21st June). The palisade parenchyma is 1—2 cell-rows wide. The cells are longish (Fig. 6E) and not closely set. Those towards the median plane of the leaf are somewhat stumpier. The length of the cell is 3—4 times its width.

The cells of the spongy parenchyma (Fig. 6L) form a layer 1—2 rows wide; as to their shape they have become similar to the palisade parenchyma cells, and also resemble them in their arrangement. Cells towards the median plane of the leaf are stumpier. The length of the cells is 2—3 times their width.

In comparison to Sample 1 the vascular bundles are much closer to each other; the distance between them is $38\ \mu$ on average (31 — $44\ \mu$). The epidermis on the upper leaf surface is flat, while on the lower one it is slightly undulated; along the veins the protrusion of the lower epidermis is of very great extent.

The thickness of the leaf is relatively uniform, but greatly reduced (Figs 1, 4L), as is the length of the palisade parenchyma cells (Fig. 2).

The length of the spongy parenchyma cells (Fig. 2) shows some increase compared to the control.

The thickness of the epidermis cell-walls (Fig. 3) is extremely reduced on both sides of the leaf.

Sample 3 (taken on 11th July). The palisade parenchyma is 1—2 cell-rows wide; the cells are tightly arranged both beside and above each other (Fig. 6F). The cells are very elongated (even those towards the median plane of the leaf) and have become thinner, so that their length is 4—6 times their width.

The cells of the spongy parenchyma (Fig. 6M) are arranged in 1 or 2 rows set closely one above the other, but less closely beside one another, compared to those of the palisade parenchyma. Their shape is longish; some of those towards the median plane of the leaf are stumper. The length of the cells is 2—3 times their width.

The vascular bundles are densely set; the distance between them is $24\ \mu$ on average (20—27 μ). The epidermis shows a slight undulation on the upper and lower surfaces alike, but in spite of this the thickness of the leaf is not significantly uneven. The protrusion of the veins is of very great extent on both leaf surfaces.

The thickness of the leaf has been greatly reduced, to about half of the thickness of the control leaf (Figs 1, 4M).

The cells of the palisade parenchyma have become much shorter, while those of the spongy parenchyma are only slightly shorter (Fig. 2); hardly any difference in length can be seen between the cells of the palisade and those of the spongy parenchyma.

The thickness of the epidermis cell-walls shows a sharp reduction on both sides of the leaf (Fig. 3).

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MINERAL COMPOSITION OF SOME ECONOMICALLY IMPORTANT GRASS SPECIES

Opinions on the feeding value of grass crops are highly divergent in practice. Not only the manner of utilization and the maturation stage of the plants, but also the fertilization, the amount of precipitation, the botanical composition and the geological origin of the soil all

influence the nutrient composition and mineral content of the grazing land. Changes in the nutrient composition of grasses are dealt with by many publications in the literature (FARRIES 1966, NEHRING 1955, KURELEC 1959, CSUKÁS 1956, WERMKE 1975, REGIUS-MÖCSÉNYI 1967 1968, REGIUS-MÖCSÉNYI—FARRIES 1969, FARRIES—REGIUS-MÖCSÉNYI 1970, 1974, REGIUS-MÖCSÉNYI—FARRIES 1973, ROTH—KIRCHGESSNER 1972b etc.). There are also data on the amounts of macroelements in the grass and on their changes in the course of development (KNOCH 1961, ROTH—KIRCHGESSNER 1972a, WERMKE 1975, BUGDOL 1961, REGIUS-MÖCSÉNYI 1967, REGIUS-MÖCSÉNYI 1968, REGIUS-MÖCSÉNYI—SZENTMIHÁLYI 1975b).

Information is available on the trends of macro- and trace elements as well, though the literature supplies relatively few data on these (ANKE *et al.* 1961/62, ANKE 1961, TÖLGYESI 1969, HARASZTI—TÖLGYESI 1961, MÓCSY—TÖLGYESI 1960, ANKE 1971, ANKE 1976, HARASZTI—TÖLGYESI 1962, MODOR—TÖLGYESI 1965).

The publications generally report on studies of the grasses of pastures, i.e. on the mineral content in the successive growths, but particularly in the first growths, of grazing lands on different soils with various grass compositions. Few experiments have been carried out with grass species and varieties grown in pure stands on the same area. In the present investigations changes in the mineral contents of some grass species and varieties in the course of development have been followed both within a single growth and over successive growths.

Ten grass species and varieties and various forms of these were grown in pure stands on the same soil and studied between 1975 and 1977. The grasses were given the same fertilization and treatment. Detailed data on the soil and fertilization of the experimental area were published by VÁRHEGYI *et al.* (1978). During the three-year experimental period samples were taken from the first growth at the leafy stage and when the panicles appeared (on cutting), from the summer after-growth when young and at a somewhat advanced stage of maturity (twice for 4 grasses and once for the other six), and from the autumn after-growth on one occasion. The changes caused by the maturation stage, and those properties of the species and varieties in which they differed from each other were established in this study, since the other factors that may have influenced their mineral contents were identical. The grasses were prepared and analysed in the manner described by REGIUS-MÖCSÉNYI—SZENTMIHÁLYI

Table 1
Common rye-grass

		Ash, %	Ca	P	Mg	K	Na	Cu	Zn	Mn
			g/kg					mg/kg		
First growth, leafy (n 7)	\bar{x}	10.30	6.29	2.51	1.48	37.03	0.46	11.29	37.49	57.34
	s	0.81	0.24	0.40	0.22	4.33	0.18	2.75	14.11	12.33
	cv%	7.85	3.84	18.83	14.89	11.70	40.13	24.35	37.64	21.50
After the appearance of panicles, at the beginning of flower- ing (n 6)	\bar{x}	8.84	6.08	2.73	1.46	28.72	0.81	7.98	26.25	63.92
	s	1.22	0.53	0.68	0.34	6.00	0.39	2.39	4.60	19.93
	cv%	13.84	8.67	24.87	23.34	20.90	48.18	29.94	17.50	31.17
Summer after-growth (n 5)	\bar{x}	7.93	6.26	2.44	1.92	19.80	0.35	11.08	18.82	68.00
	s	0.58	0.88	0.27	0.23	2.21	0.09	1.13	5.92	19.04
	cv%	7.35	14.02	10.87	12.13	11.18	24.59	10.19	31.44	28.00
Autumn after-growth (n 6)	\bar{x}	8.93	5.95	2.47	2.90	24.85	0.58	12.70	36.10	69.20
	s	0.72	1.76	0.43	1.41	5.04	0.36	4.00	6.12	19.14
	cv%	8.12	29.59	17.31	48.52	20.32	52.65	31.54	16.96	27.67

Table 2
Meadow fescue

		Ash, %	Ca	P	Mg	K	Na	Cu	Zn	Mn
			g/kg					mg/kg		
First growth, leafy (n 10)	\bar{x}	10.85	6.97	2.24	1.65	37.91	0.12	11.74	29.67	81.18
	s	0.69	0.46	0.29	0.33	3.84	0.05	1.18	6.45	12.59
	cv%	6.32	6.61	13.12	20.32	10.12	40.62	10.08	21.74	15.51
After the appearance of panicles (n 9)	\bar{x}	9.34	6.71	2.31	1.53	31.38	0.12	8.00	24.79	99.63
	s	1.22	0.70	0.30	0.36	6.27	0.06	2.76	7.77	41.74
	cv%	13.11	10.41	13.13	23.44	20.00	45.97	34.39	31.35	41.90
Summer after-growth (n 12)	\bar{x}	9.25	8.33	2.50	2.48	22.93	0.11	10.18	18.52	120.16
	s	1.05	0.75	0.35	0.30	4.29	0.06	1.57	5.40	20.25
	cv%	11.41	8.94	13.97	11.94	18.72	51.84	15.45	29.15	16.84
Autumn after-growth (n 12)	\bar{x}	9.91	6.53	2.44	3.16	28.85	0.08	12.10	28.87	112.04
	s	1.00	2.43	0.22	1.26	7.94	0.02	4.64	5.84	34.59
	cv%	10.13	37.30	8.92	35.96	27.51	27.10	38.33	20.24	29.09

Table 3
Orchard grass

		Ash, %	Ca	P	Mg	K	Na	Cu	Zn	Mn
			g/kg					mg/kg		
First growth, shooting (n 11)	\bar{x}	10.13	4.65	2.25	1.42	37.98	1.09	11.82	24.05	115.83
	s	1.05	0.87	0.22	0.28	6.89	0.51	1.45	5.29	24.22
	cv%	10.34	19.09	9.71	19.76	18.13	46.32	12.27	21.98	20.91
After the appearance of panicles, at the beginning of flower- ing (n 9)	\bar{x}	8.41	4.21	2.37	1.31	28.60	1.38	7.43	21.77	135.33
	s	0.52	0.75	0.19	0.21	2.32	0.69	1.12	3.89	23.24
	cv%	6.13	17.82	7.97	15.68	8.12	50.67	15.07	17.85	17.18
Summer after-growth, young (n 5)	\bar{x}	7.32	7.26	2.12	2.62	25.90	1.06	11.54	22.92	101.48
	s	0.42	1.44	0.67	0.51	4.71	0.36	0.98	4.38	20.03
	cv%	5.77	19.78	19.52	19.52	18.19	34.43	8.48	19.09	19.73
Summer after-growth, older (n 9)	\bar{x}	9.82	6.32	2.33	2.16	25.56	1.00	9.78	14.94	164.44
	s	0.43	0.40	0.34	0.24	4.29	0.47	2.20	2.14	34.84
	cv%	4.41	6.40	14.57	11.13	16.80	47.19	22.54	14.30	21.19
Autumn after-growth (n 16)	\bar{x}	9.60	5.79	2.50	3.14	26.07	1.02	12.59	27.96	118.88
	s	1.45	2.54	0.34	0.91	5.29	0.38	3.95	10.36	40.79
	cv%	15.16	43.93	13.49	28.89	20.31	36.96	31.35	37.07	34.31

(1975a). A total of 10 grass species, including 35 varieties, were examined for 3 years, on four or five occasions a year. The total number of samples was 358.

The average value (\bar{x}) of the ash and mineral contents in the successive growths of the examined grasses are contained in Tables 1–10, together with the variation coefficients (cv%). Table 1 gives data on common rye-grass (*Lolium perenne*). In the leafy samples of the first growth the average proportion of inorganic matter was 10.3%, which decreased non-significantly to 8.8% by the time of cutting. The ash content was 7.9% in the summer after-

growth and 8.9% in the autumn after-growth. The calcium content was about 6 g/kg, hardly changing in the successive growths. The phosphorus content (approx. 2.5 g/kg) was nearly identical in all growths. The magnesium content ranged from 1.5 to 3 g/kg. No significant difference in magnesium content was found between the growths, although the magnesium level of the autumn after-growth was twice as high as that of the first growth (3 and 1.5 g/kg, respectively).

There were no significant differences between the growths as regards potassium content either. The largest quantity of potassium was found in the leafy sample of the first growth; this decreased until cutting. In the summer after-growth a further reduction in potassium

Table 4
Smooth brome-grass

		Ash, %	Ca	P	Mg	K	Na	Cu	Zn	Mn
			g/kg					mg/kg		
First growth, leafy (n 6)	\bar{x}	10.38	4.83	2.40	1.25	37.68	0.09	12.20	22.27	73.33
	s	1.04	0.89	0.31	0.30	3.69	0.02	1.29	5.83	27.15
	cv%	10.05	14.37	12.72	23.65	9.79	27.84	10.57	26.20	37.02
After the appearance of panicles (n 4)	\bar{x}	9.25	4.08	2.20	0.92	32.03	0.05	8.28	20.98	61.80
	s	0.86	0.37	0.58	0.06	2.84	0.01	2.73	5.35	17.50
	cv%	9.31	9.08	26.50	6.49	8.87	23.06	32.98	25.50	28.66
Summer after-growth (n 10)	\bar{x}	8.88	6.82	2.43	2.60	25.92	0.08	10.64	19.93	123.33
	s	1.42	1.20	0.39	0.54	4.19	0.01	1.35	5.49	50.26
	cv%	16.00	17.65	16.20	20.64	16.17	37.79	12.78	29.07	40.75
Autumn after-growth (n 8)	\bar{x}	9.60	6.36	2.16	3.59	25.73	0.13	12.85	34.15	134.21
	s	1.05	2.69	0.22	1.22	8.00	0.05	3.77	10.80	38.55
	cv%	10.98	42.24	10.32	33.89	31.10	39.03	29.37	31.62	28.72

Table 5
Tall fescue

		Ash, %	Ca	P	Mg	K	Na	Cu	Zn	Mn
			g/kg					mg/kg		
First growth, leafy (n 9)	\bar{x}	10.4	4.59	2.39	1.85	35.77	0.88	10.03	23.03	59.76
	s	0.51	0.57	0.24	0.31	3.61	0.40	1.19	7.69	17.50
	cv%	5.07	12.52	9.95	16.75	10.09	45.30	11.82	34.52	29.28
After the appearance of panicles (n 8)	\bar{x}	8.09	4.53	2.34	1.73	25.83	1.17	7.89	20.03	66.13
	s	0.40	0.70	0.46	0.33	2.48	0.58	2.68	4.72	16.82
	cv%	4.90	15.46	19.60	19.28	9.60	49.78	33.86	23.58	25.44
Summer after-growth, young (n 9)	\bar{x}	9.30	5.27	2.04	2.64	24.33	0.99	8.90	13.51	77.21
	s	0.67	0.39	0.35	0.44	4.18	0.34	2.33	1.67	17.94
	cv%	7.24	7.39	17.12	16.83	17.16	34.20	26.17	12.38	23.23
Summer after-growth, older (n 5)	\bar{x}	8.05	6.36	3.74	2.60	22.94	0.96	10.70	19.36	91.86
	s	0.22	1.08	0.73	0.40	2.80	0.29	1.97	1.86	12.27
	cv%	2.78	16.92	19.62	21.51	12.25	30.84	11.18	9.61	13.35
Autumn after-growth (n 14)	\bar{x}	8.86	4.97	2.29	4.29	22.91	1.07	11.56	22.09	79.41
	s	0.75	2.03	0.27	1.07	5.39	0.46	2.35	8.94	22.41
	cv%	8.45	40.78	11.59	24.75	23.53	43.10	20.30	40.50	28.10

Table 6
Reed canary grass

		Ash, %	Ca	P	Mg	K	Na	Cu	Zn	Mn
			g/kg					mg/kg		
First growth, leafy, shooting (n 5)	\bar{x}	9.98	5.66	2.66	1.88	38.54	0.13	13.30	33.10	63.3
	s	1.05	1.11	0.15	0.40	5.79	0.05	1.30	13.80	7.9
	cv%	10.53	19.57	5.63	23.63	15.03	42.93	9.60	41.50	12.4
After the appearance of panicles (n 4)	\bar{x}	8.52	5.00	2.48	1.45	26.30	0.08	11.00	23.90	49.8
	s	0.58	1.07	0.78	0.83	5.74	0.05	4.47	5.40	16.3
	cv%	8.86	21.35	31.48	65.58	21.84	56.60	40.62	22.60	32.8
Summer after-growth (n 9)	\bar{x}	8.58	6.47	2.14	3.28	27.00	0.10	11.26	24.76	84.9
	s	0.92	1.17	0.27	0.86	4.17	0.04	1.33	4.43	17.6
	cv%	10.79	18.14	12.68	26.16	15.43	43.50	11.83	17.90	20.7
Autumn after-growth (n 8)	\bar{x}	10.02	5.81	2.18	4.21	25.78	0.10	11.85	29.69	108.2
	s	0.95	2.08	0.41	1.00	10.23	0.06	2.75	3.93	21.3
	cv%	9.49	35.55	18.64	23.75	39.70	53.84	23.23	13.24	19.0

Table 7
Timothy grass

		Ash, %	Ca	P	Mg	K	Na	Cu	Zn	Mn
			g/kg					mg/kg		
First growth, leafy (n 8)	\bar{x}	9.64	5.06	2.33	1.31	35.78	0.24	12.94	42.35	82.66
	s	0.58	0.75	0.33	0.18	4.39	0.20	1.48	9.95	23.38
	cv%	5.97	14.91	14.22	13.73	12.27	82.32	11.43	23.49	28.29
Before the appearance of panicles (n 7)	\bar{x}	8.56	5.31	2.63	1.12	29.51	0.18	8.99	29.70	94.43
	s	0.95	0.59	0.29	0.31	5.21	0.11	2.31	4.24	42.63
	cv%	11.08	11.13	11.08	28.04	17.65	57.49	25.75	14.28	45.14
Summer after-growth, young (n 7)	\bar{x}	7.70	5.35	2.20	1.93	21.60	0.22	5.95	17.55	86.75
	s	0.75	0.77	0.28	0.41	2.10	0.22	3.68	1.61	15.86
	cv%	9.70	14.39	12.86	21.54	9.71	98.54	61.77	25.30	18.28
Summer after-growth, before flowering (n 4)	\bar{x}	8.03	7.84	2.27	2.10	23.77	0.25	11.47	26.27	92.83
	s	1.31	1.38	0.40	0.40	3.41	0.18	0.95	3.66	14.63
	cv%	16.32	17.60	17.72	18.88	14.33	76.33	8.29	13.95	14.65
Autumn after-growth (n 9)	\bar{x}	9.03	5.34	2.16	3.47	25.34	0.31	13.51	36.06	91.48
	s	1.09	1.70	0.39	0.40	4.02	0.15	5.03	15.15	24.40
	cv%	12.02	31.84	17.92	15.33	15.88	47.62	41.68	42.01	26.67

was observed, while in the autumn after-growth the potassium level showed a slight increase. The sodium content fluctuated widely throughout the whole period of investigation (between 0.36 and 0.80 g/kg); particularly great differences were found on cutting in samples taken from the first growth. According to HASLER (1962), SAALBACH (1973) and BUGDOL (1964) rye-grass is one of the grass species richest in sodium. This statement has not been confirmed unambiguously by the current analyses, the results showing considerable deviation (BRUNE 1975). None of the other grass species examined displayed such wide fluctuations in sodium content as this.

In the first growth the copper content declined until cutting, but in the summer after-growth it reached the level of the leafy sample in the first growth, and in the autumn after-growth it was higher than in the other samples. The differences between the individual growths were significant ($P = 5\%$). The copper content of common rye-grass did not fall below the requirement of cattle (8 mg/kg dry matter) throughout the whole vegetation period, thus exceeding the average copper level of the grasses grazed in practice (ANKE 1961, REGIUS-MÖCSÉNYI—NAGY 1977). The zinc content of rye-grass was nearly identical in the leafy samples of the first growth and in the autumn after-growth (37.5 and 36.2 mg/kg, respectively); it was lower at the time of cutting (26.4 mg/kg) and reached a minimum in the summer after-growth

Table 8
Kentucky blue grass

		Ash, %	Ca	P	Mg	K	Na	Cu	Zn	Mn
			g/kg					mg/kg		
First growth, leafy (n 8)	\bar{x}	9.00	4.89	2.43	1.49	27.56	0.13	12.73	35.21	58.21
	s	0.49	1.29	0.22	0.36	6.02	0.08	0.80	5.44	10.27
	cv%	5.46	26.39	8.94	24.20	21.84	59.09	8.20	13.45	17.04
After the appearance of panicles (n 7)	\bar{x}	7.65	5.09	2.49	1.09	24.89	0.07	7.44	24.03	68.14
	s	1.22	0.77	0.37	0.37	5.88	0.03	1.29	7.12	29.86
	cv%	15.91	15.17	14.80	33.97	23.62	47.01	17.35	29.63	43.82
Summer after-growth (n 8)	\bar{x}	8.91	8.08	2.18	2.47	19.95	0.14	8.83	19.14	76.78
	s	1.50	1.75	0.29	0.98	3.75	0.08	3.62	6.42	14.05
	cv%	16.83	21.64	13.42	39.56	18.83	57.44	41.12	83.54	18.30
Autumn after-growth (n 10)	\bar{x}	9.76	6.10	2.34	3.64	22.36	0.13	10.61	28.24	79.77
	s	1.05	2.59	0.33	0.93	5.39	0.07	5.92	7.74	22.08
	cv%	10.74	42.43	14.20	25.54	24.09	53.96	55.82	27.45	27.60

Table 9
Red fescue grass

		Ash, %	Ca	P	Mg	K	Na	Cu	Zn	Mn
			g/kg					mg/kg		
First growth, leafy (n 10)	\bar{x}	10.08	5.53	2.32	1.45	34.97	0.10	12.98	30.56	95.27
	s	0.66	1.24	0.35	0.21	2.78	0.03	2.13	5.91	17.88
	cv%	6.58	22.57	15.03	14.35	7.94	25.81	16.39	19.33	18.77
After the appearance of panicles (n 9)	\bar{x}	8.30	5.61	2.41	0.90	22.27	0.06	6.26	19.43	54.41
	s	0.83	1.00	0.35	0.40	7.58	0.02	1.33	7.95	27.05
	cv%	9.97	17.81	14.69	44.27	34.06	25.75	21.33	40.90	50.81
Summer after-growth, young (n 7)	\bar{x}	6.70	8.09	2.10	2.33	24.86	0.07	10.87	15.91	100.25
	s	0.71	0.97	0.19	0.38	3.21	0.01	1.01	5.06	9.26
	cv%	8.19	12.02	9.12	16.02	12.91	18.45	9.27	31.73	9.24
Summer after-growth, older (n 5)	\bar{x}	9.98	6.66	2.44	1.88	18.72	0.06	3.30	13.30	94.00
	s	0.91	0.96	0.15	0.11	3.96	0.01	1.96	2.79	12.00
	cv%	8.09	14.42	8.13	5.71	21.18	36.60	36.62	20.96	12.77
Autumn after-growth	\bar{x}	9.85	6.14	2.34	3.63	22.80	0.09	9.61	24.41	91.79
	s	1.09	2.56	0.42	1.08	6.70	0.07	3.49	9.01	19.32
	cv%	11.12	41.64	18.00	29.98	29.39	76.74	36.32	36.91	21.05

Table 10
French rye-grass

		Ash, %	Ca	P	Mg	K	Na	Cu	Zn	Mn
			g/kg					mg/kg		
First growth, on appearance of panicles (n 4)	\bar{x}	9.27	4.38	2.15	1.57	33.22	0.10	9.33	20.73	60.55
	s	1.19	0.48	0.38	0.15	3.30	0.03	1.91	4.64	4.74
	cv%	12.80	11.00	17.86	9.60	9.92	32.65	20.54	22.37	7.84
At the beginning of flowering (n 4)	\bar{x}	7.07	3.88	2.25	0.80	19.38	0.05	5.63	15.08	42.50
	s	0.36	0.43	0.17	0.18	5.07	0.01	2.23	2.83	11.30
	cv%	5.14	11.15	7.37	22.53	26.16	24.49	39.62	18.78	26.58
Summer after-growth (n 5)	\bar{x}	7.37	6.30	2.38	2.26	20.96	0.10	8.00	15.72	76.42
	s	0.55	0.60	0.20	0.63	3.75	0.04	4.15	4.12	9.55
	cv%	7.43	9.52	8.57	27.79	17.87	44.94	51.84	26.18	12.50
Autumn after-growth (n 6)	\bar{x}	9.91	5.70	2.43	3.63	26.25	0.14	11.32	23.83	86.37
	s	1.04	2.25	0.35	1.09	9.13	0.02	1.19	6.43	21.92
	cv%	10.49	39.52	14.58	30.18	34.78	11.74	10.50	26.97	25.38

(18.8 mg/kg). There were no significant differences between the successive samples. Common rye-grass does not cover the zinc requirements of cattle (50–60 mg/kg dry matter) at any stage of development when grown on a calcareous soil like that in the study. Plants grown on calcareous soils contain less zinc than those grown on acid soils (ANKE 1965).

The manganese content shows hardly any change in the successive growths, in agreement with the literary data (ANKE 1961). The manganese content of common rye-grass is of medium level compared to that of other grasses. Grasses are generally known to be rich in manganese, and it is only in extreme cases that the grasses of grazing lands do not cover the manganese requirements of cattle (50–60 mg/kg dry matter).

The mineral content of meadow fescue (*Festuca pratensis*) is shown in Table 2. The ash content decreased significantly until cutting ($P = 1.0\%$), then remained more or less on the same level in the summer and autumn after-growths (9.3, 9.2 and 9.9%, respectively). The calcium content declined slightly until cutting; the summer after-growth contained significantly more calcium than either the first growth or the autumn after-growth. Compared to the calcium level characteristic of grasses the summer after-growth was rich in calcium, containing an average of 6.0 g/kg dry matter. The phosphorus content was nearly the same in the different growths (2.2–2.5 g/kg), in agreement with the literary data (HENNIG 1969, BUGDOL 1964, ROTH—KIRCHGEISSNER 1972a). As in the case of common rye-grass, no growth of meadow fescue would cover the phosphorus requirements of cattle (3 g/kg dry matter).

The magnesium content did not change in the first growth (1.6–1.5 g/kg dry matter), while the summer and autumn growths contained significantly more magnesium ($P = 1.0\%$) than the first growth.

The potassium content showed a similar tendency to that in common rye-grass except that the differences between the growths were significant ($P = 1.0$ and 0.1% , respectively).

Meadow fescue is one of the grasses which is poor in sodium; the amount of sodium in the different growths ranged from 0.08 to 0.12 g/kg dry matter. Grasses in general are known to contain little sodium, so sodium supplements are indispensable during the grazing period.

Changes in the copper content corresponded to those in common rye-grass, except that owing to the lower variation in the values the differences in the first growth were significant ($P = 0.1\%$).

The zinc content of meadow fescue agreed in tendency with that of common rye-grass, but with the exception of the first growth the differences were highly significant ($P = 0.1\%$), due again to the lower variation. According to the analytical results, meadow fescue is rich in manganese; the average manganese content of the different growths was found to range between 81.2 and 120.2 mg/kg dry matter, in contrast to the literature, which places meadow fescue, with a manganese content of 45 mg/kg dry matter, among the grasses poor in manganese (ANKE 1961, ANKE *et al.* 1961/62).

Table 3 contains the results obtained for orchard grass (*Dactylis glomerata*) on the basis of 5 samplings. The ash content showed a highly significant ($P = 0.1\%$) reduction in the first growth until cutting, and between the young and the more mature summer after-growths; the ash content of the autumn after-growth was nearly identical to that in the young crops of the two previous growths.

In the first and second growths of orchard grass calcium content was similar in tendency to the ash content; in the summer after-growths the calcium level was significantly ($P = 0.1\%$) higher than in the first growth (4.6–4.2 g/kg); the autumn after-growths contained 5.8 g Ca/kg dry matter. Changes in the magnesium and potassium contents were similar in tendency to those in the two previous grasses, but without significant differences. Orchard grass is the richest in sodium among the grass species examined; the sodium content in the different growths was found to range between 1.0 and 1.38 g/kg dry matter. According to SAALBACH (1973), as a response to sodium fertilization orchard grass is able to take up nearly ten times its normal sodium content (0.3–1.5 g/kg depending on the soil) unlike timothy grass and Kentucky blue grass, which hardly take up any more sodium even after sodium fertilization. The soil of the trial plots was not poor in sodium, which is presumably the reason for the relatively high sodium content of orchard grass compared to the other grasses. The different volume of sodium uptake may be connected with the development of the root system (ANKE 1961, BUGDOL 1964). There were no substantial differences either in copper or zinc content compared to the previous species; older grasses contained significantly less copper and zinc ($P = 0.1\%$ and 5.0% , respectively) than young ones ($P = 0.1\%$).

According to the analytical results, orchard grass contains the largest amount of manganese among the grasses examined. The lowest average value was 101.5 mg/kg, the highest 164.4 mg/kg dry matter. ANKE (1961) found an average of 94 mg Mn/kg dry matter in orchard grass.

Table 4 contains the analytical results for smooth brome-grass (*Bromus inermis*). In the first growth the ash and calcium contents, and to some extent the phosphorus, magnesium, potassium and zinc contents were reduced by the time of cutting, as was the amount of manganese. In the case of calcium, potassium and manganese the reduction was significant ($P = 0.1\%$, $P = 5\%$ and $P = 1.0\%$, respectively). In the summer after-growths the increase in ash and calcium contents was non-significant, while the increase in magnesium and manganese contents was significant ($P = 0.1\%$ and $P = 1.0\%$, respectively) compared to the first growth; the potassium and zinc contents decreased. Smooth brome-grass, like meadow fescue, belongs to the group of grasses with very low sodium contents (0.05–0.13 g/kg dry matter). The ash and mineral contents of the autumn after-growth are also similar to those in meadow fescue.

Table 5 presents data on tall fescue (*Festuca arundinacea*) on the basis of samples taken on 5 different occasions. The ash, calcium, phosphorus, magnesium, potassium, sodium copper and zinc contents of the first growth showed changes similar to those in orchard grass. The manganese level, however, was only about half of that in orchard grass. In the summer after-growth calcium showed a lower and magnesium a higher rate of increase; the manganese did not reach the level found in orchard grass. In the autumn after-growth the tendency of change in the ash, calcium, phosphorus, potassium, copper and zinc contents agreed with that

in the autumn after-growth of orchard grass, though the values were lower. The magnesium content was very high (4.3 g/kg), while the manganese content was medium. Tall fescue belongs to the group of grasses with high sodium contents; it is only the first growth that contains less sodium than orchard grass.

Data for green reed canary grass (*Baldingera arundinacea*) are presented in Table 6. In the first growth both the ash content and the amounts of the individual elements decreased until cutting, but the decrease was not significant in any case owing to the small number of samples. In the summer after-growth the calcium, magnesium and manganese contents increased compared to the first growth; in the autumn after-growth the amounts of magnesium and manganese continued to increase, the latter to a significant extent both in the summer and autumn after-growths ($P = 1.0\%$). As regards sodium content, reed canary grass belongs to the group of grasses with low sodium contents (0.08–0.13 g/kg dry matter).

Data on timothy grass (*Phleum pratense*) are contained in Table 7. With the exception of calcium, phosphorus and manganese the amounts of elements in the first growth decreased until cutting. The calcium content in the young summer after-growth and the magnesium content in the autumn after-growth were significantly higher ($P = 1.0\%$) than in the first growth and the summer after-growth. With respect to sodium content timothy grass cannot be placed among the grasses with very low Na contents, since its sodium level was found to be higher than these (0.18–0.30 g/kg dry matter).

The mineral composition of Kentucky blue grass (*Poa pratensis*) differs from that of timothy grass in the somewhat smaller quantities of certain elements, particularly of manganese; in addition, it belongs to the group of grasses with low sodium contents (0.07–0.14 g/kg), while the calcium content in the summer and autumn after-growths exceeds that of timothy grass (Table 8).

In the first growths of red fescue grass (*Festuca rubra*, Table 9) and French rye grass (*Arrhenatherum elatius*, Table 10) the amount of copper at the time of cutting does not cover the copper requirements of cattle (8 mg/kg dry matter). Red fescue grass contains 6.3 mg/kg and French rye-grass 5.6 mg/kg copper, while in older stands of the summer after-growths of red fescue grass only 3.3 mg/kg copper was found; the reduction was significant in each case ($P = 0.1\%$). Both grasses belong to the low Na-content group. French rye-grass contained a medium amount, and red fescue (except in the first cutting) a fairly large amount of man-

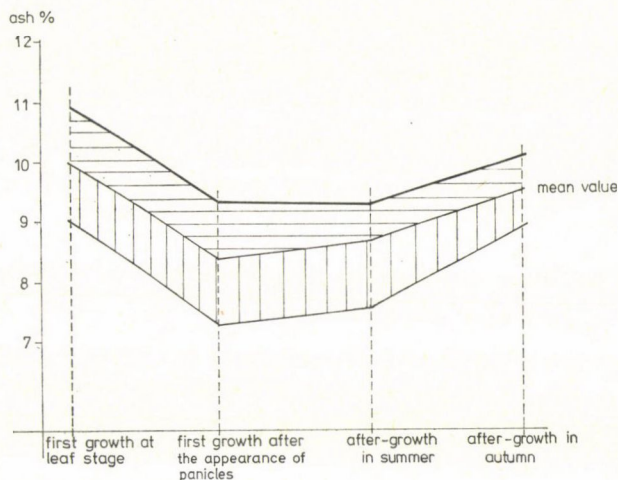


Fig. 1. Trend in ash contents of grasses during vegetation

ganese. The tendency of changes in the amounts of other elements contained in the different growths conforms with the general rules. The calcium contents of both red fescue grass and French rye-grass showed a significant decrease in the first growth ($P = 1.0\%$), and the summer after-growths of both grass species contained significantly more calcium than the first growths ($P = 1.0\%$ and $P = 0.1\%$, respectively). The increase in magnesium content was also significant in both grasses ($P = 1.0\%$).

The tables reveal that in the examined grass species the mineral contents were highly varied in order of magnitude but nearly identical in tendency. The general tendency of changes

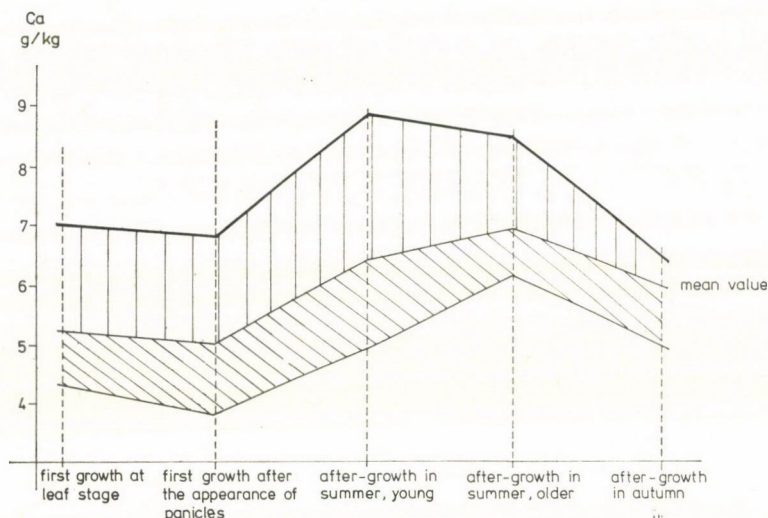


Fig. 2. Trend in calcium contents of grasses during vegetation

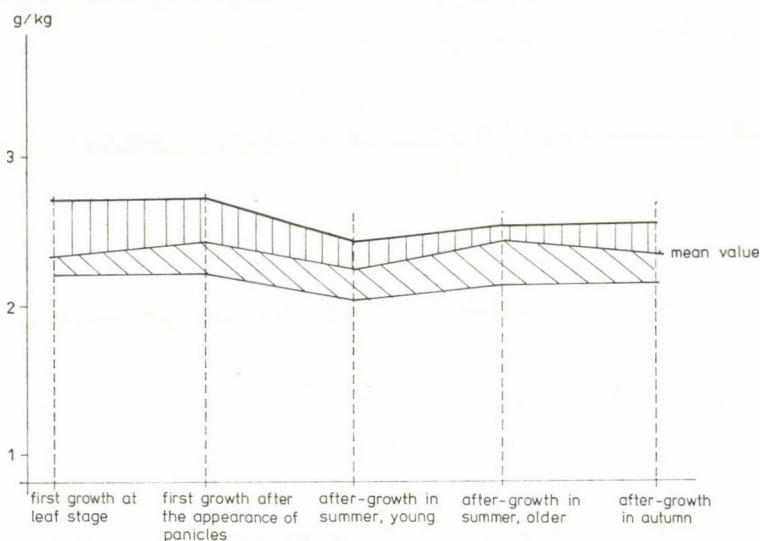


Fig. 3. Trend in phosphorus contents of grasses during vegetation

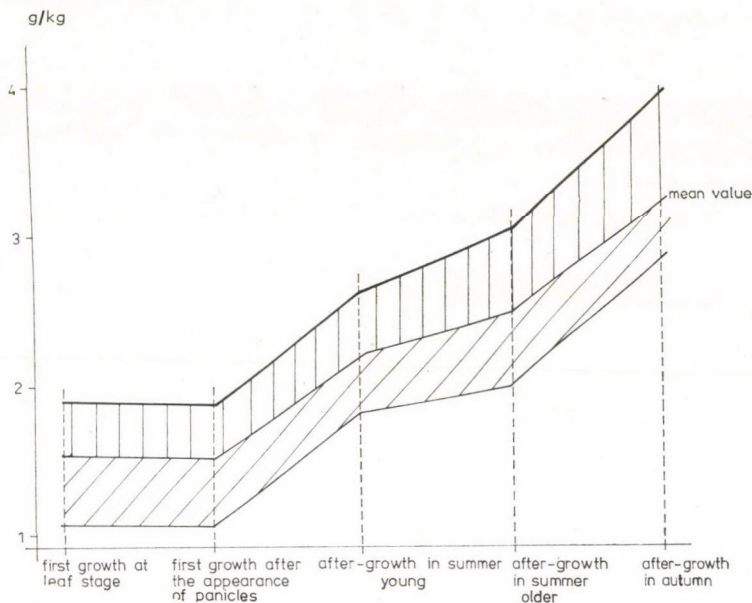


Fig. 4. Trend in magnesium contents of grasses during vegetation

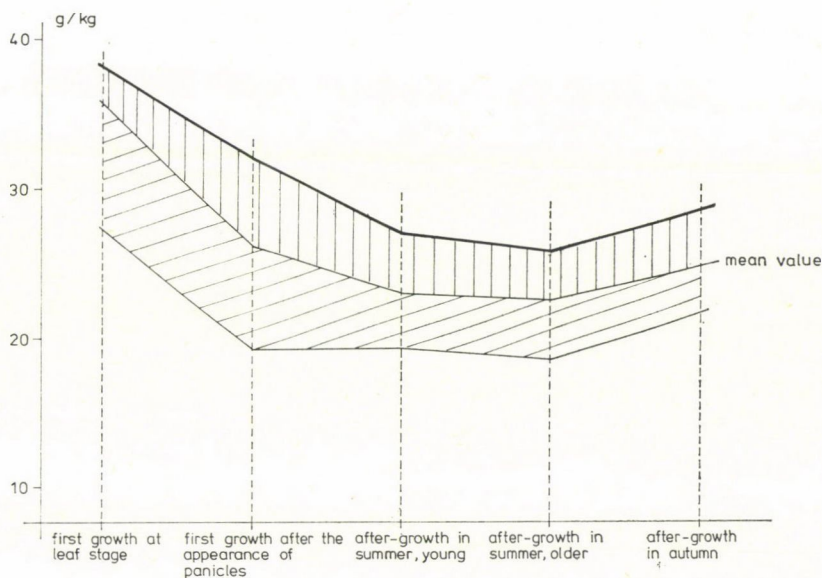


Fig. 5. Trend in potassium contents of grasses during vegetation

in the ash content and the amounts of the individual macro- and trace elements is shown in Figs 1—9 on the basis of the average values for the grasses examined.

In Fig. 1 the data for ash content are presented. In the first growth both the mean value and extreme values of ash content decrease from the leafy stage to the appearance of the panicles; in the summer after-growth the ash content is higher again and rises further in

the autumn after-growth, though it no longer reaches the level of the first growth at the leafy stage. According to the analytical results meadow fescue contained the largest amount and French rye-grass the smallest amount of ash over the whole period of the study.

The calcium content also decreased until the appearance of the panicles (Fig. 2), but in the summer after-growth it was much higher than in the first growth; in the autumn after-growth the calcium level was again lower. This element, like ash, is found in the largest quantities in meadow fescue and in the smallest quantities in French rye-grass.

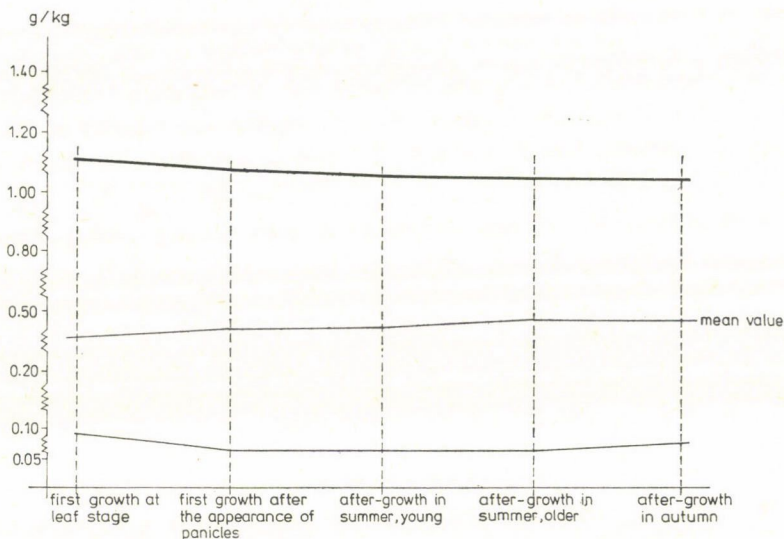


Fig. 6. Trend in sodium contents of grasses during vegetation

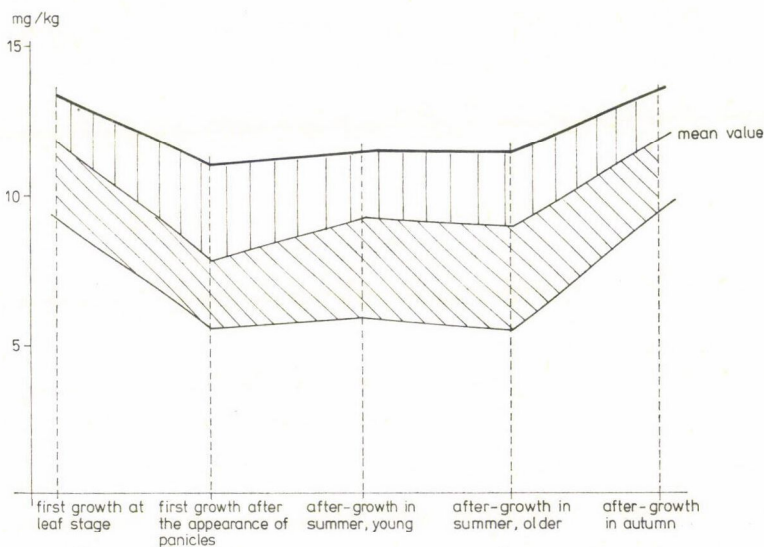


Fig. 7. Trend in copper contents of grasses during vegetation

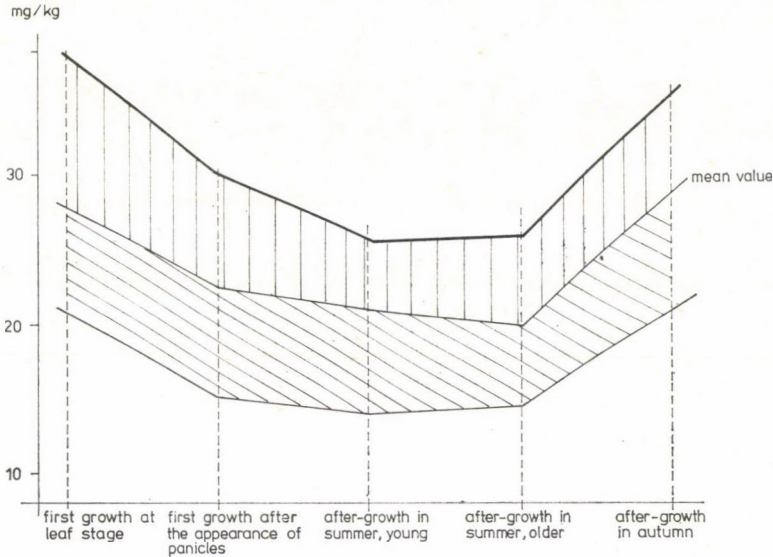


Fig. 8. Trend in zinc contents of grasses during vegetation

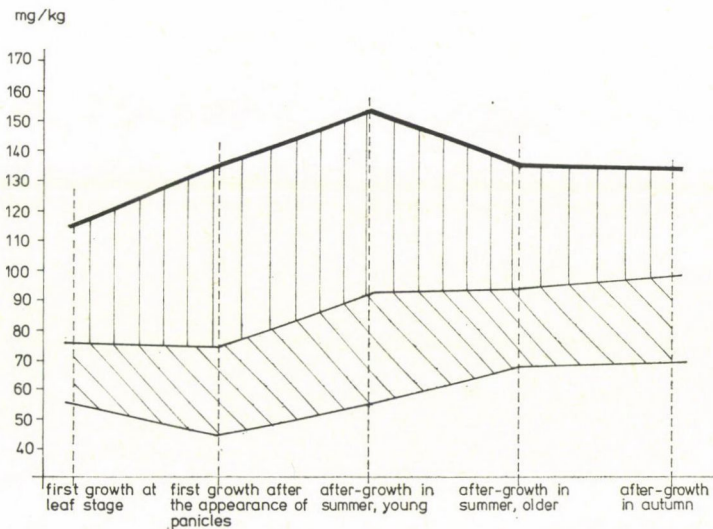


Fig. 9. Trend in manganese contents of grasses during vegetation

Figure 3 illustrates the trend of changes in the phosphorus content. Neither the species nor the development stage had much influence on the phosphorus level. All the values obtained ranged between 2.20 and 2.80 g/kg dry matter (it was only in one case — in the summer after-growth of tall fescue — that an average of 3.6 g/kg phosphorus was found).

The magnesium content gradually increased from the first growth to the autumn after-growth (Fig. 4). According to HENNIG (1972) the rising magnesium level is accompanied by an improvement in the quality of the protein and by a simultaneous decrease in potassium

uptake. Contrasting tendencies were also observed in the changes in magnesium and potassium contents from spring to autumn (Fig. 5), although a reduction in the potassium content of the autumn after-growth did not occur in all species; in the case of common rye-grass and timothy grass, for example, an occasional increase was even found.

As was mentioned above, there are great differences in sodium content between the species (Fig. 6). The results show that the species can be divided into groups with low, medium and high sodium content. A large amount of sodium is found in orchard grass and tall fescue, while timothy grass and common rye-grass contain medium quantities and the other species examined very small quantities of sodium. The sodium uptake is a specific feature (TÖLGYESI 1969) and is related to the development of the root system (ANKE 1961, BUGDOL 1964).

Figure 7. shows the changes in copper content. The copper content is closely related to maturation; young grasses always contain more copper than older ones. In the course of vegetation the copper content shows a trend similar to that of the ash content.

The zinc content follows the same trend as the copper and ash contents. The species included in the study were found to be generally poor in zinc; the values obtained were below those published in the literature.

Figure 9 shows the tendency of the manganese content to increase from spring to autumn. Grasses are generally rich in manganese, though there are great differences between the species; in the present study orchard grass was the richest in manganese, but red fescue grass and meadow fescue also contained large amounts of this element. The increase from spring to autumn may be so great that the manganese content of the autumn after-growth will be as much as twice that of the first growth, as was the case with smooth brome-grass in the present study.

In pure stands of grasses grown on the same soil type the ash content was the highest (9.0—11.0%) at the leafy stage of the first growth, after which it decreased until cutting. The summer after-growth contained less ash (7.1—9.5%), while the autumn after-growth contained relatively more (8.6—10.2%).

The tendency in the calcium content corresponded to that of the ash content in the first growth, compared to which the summer after-growth contained more and the autumn after-growth less calcium.

At the development stages examined the grasses did not always contain enough calcium to cover the requirements of cattle. The calcium requirement of a 650 kg cow producing 10 litres milk a day is 65 g/day. If, for example, this cow consumes an amount corresponding to 12 kg dry matter from a French rye-grass stand after the appearance of the panicles, its daily calcium supply will be only 46.8 g.

There are hardly any differences in phosphorus content between the grass species, and even the successive growths do not essentially differ in this respect. In no cases would the phosphorus contents of the grasses cover the requirements of cattle; phosphorus supplements must therefore be given throughout the grazing period, particularly considering that the phosphorus supply is closely connected with the feed uptake (KIRCHGESSNER—ROTH 1972).

The magnesium content, like the calcium content, decreased in the first growth until cutting; the summer after-growth contained more magnesium, and in the autumn after-growth the amount of this element further increased compared to the first growth.

The potassium content declined as the grasses aged: the summer after-growth contained much less potassium than the first growth, while in the autumn after-growth the potassium level was nearly the same as in the summer after-growth (ANKE *et al.* 1961/62, BUGDOL 1964, HENNIG 1972).

With respect to sodium content the grass species examined differ from one another, most of them belonging to the group of grasses with low sodium contents (0.05—0.14 g/kg dry matter); medium amounts of sodium are contained in timothy grass and common rye-grass,

and there are large quantities of sodium in tall fescue and orchard grass (0.93—1.38 g/kg). Within these categories (grasses with low, medium and high sodium contents) the sodium content fluctuates greatly in the different grasses (BRUNE 1975, ROTH—KIRCHGESSNER 1972, WERMKE 1975). None of the grasses examined contains enough sodium to cover the requirements of cattle (ANKE *et al.* 1961/62, BUGDOL 1964, HENNIG 1972, REGIUS-MÖCSÉNYI—NAGY 1977), so sodium supplements must always be given in the grazing season.

The copper content shows a tendency similar to that of the ash content. Grasses in general, and aged ones in particular, contain only small amounts of copper. The grasses examined never reached the development stage at which the copper content is sharply reduced in consequence of senescence, except for an older crop of the summer after-growth of red fescue grass, in which 3.3 mg/kg copper was found. In the summer months the grasses of grazing lands may contain even less copper than this (REGIUS-MÖCSÉNYI—NAGY 1977), possibly causing copper deficiency in animals kept out at pasture, unless they are given copper supplements.

Grasses contain relatively little zinc, especially in the summer after-growth. ANKE *et al.* (1961/62) found the zinc level of grazing lands to rise from the first growth to autumn. The grass species included in the present study showed no such tendency.

The manganese supply of animals kept out at pasture is satisfactory, since grasses are rich in manganese. There are, however, considerable differences between the species as regards manganese content. Of the grass species examined, the first growth of French rye-grass contained the smallest quantity of manganese. The manganese level in the grasses steadily rises from the first growth to the autumn after-growth; in some grasses, e.g. smooth brome-grass, the manganese content is nearly twice as high in autumn as in the first growth. The largest amount of manganese over the whole period of the study was found in orchard grass; red fescue grass and meadow fescue also contained large quantities of this element. Similar results were reported by ANKE *et al.* (1961/62).

None of the grass species examined, whether grown in pure or mixed stands, would cover the phosphorus, sodium or zinc requirements of grazing cattle; the manganese supply would be ensured in every case; the calcium and copper levels are occasionally low in some grasses. As the grass ages the copper content may be reduced to such an extent that, without copper supplements, deficiency symptoms may arise.

*

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DETECTION OF ENDOGENOUS, FREE FORMALDEHYDE IN PLANTS AND ITS RELATIONSHIP WITH PHOTOSYNTHESIS

The presence of endogenous, free formaldehyde in living plant and animal tissues, the conditions under which it is formed and its *in vivo* reactions belong to the intensively investigated questions of biochemistry these days. Early studies on photosynthesis assumed the formation of formaldehyde in the first step of carbon dioxide assimilation. The basis of this hypothesis was that formaldehyde, as a one-carbon compound, occurs in the same oxidation state as carbohydrates, and that in an aqueous solution and alkaline medium formaldehyde condenses directly to carbohydrate. Later, several variations of the formaldehyde hypothesis were presented, but all were rejected, as BAYER's (1870) conception was not confirmed by analyses.

Finally, the classical experiments of CALVIN (1955, 1974), CALVIN—BENSON (1948), BENSON—CALVIN (1950), CALVIN—BASSHAM (1962) fully excluded the possibility of formaldehyde formation in the short term photosynthesis investigations. Due to technical difficulties the initial steps of carbon fixation were not cleared up satisfactorily, so further assumptions were introduced concerning carbon dioxide fixation, besides the Calvin-cycle. In this way, based on the observations of KORSHAK *et al.* (1965), HATCH—SLACK (1966, 1970) discovered the C_4 metabolism pathway as an alternative of the ribulose-diphosphate-carboxylase system. Among Hungarian investigators NOSTICZIUS (1973, 1976) tried to prove the possibility of a third solution in an indirect way, sketching the role of formaldehyde and glycolaldehyde in the carbon metabolism.

Actually, the question of whether free, endogenous formaldehyde occurs or not has been left open.

According to the literature, from the fractions of one-carbon metabolism the hydroxymethyl ($HO-CH_2$)-group ("active formaldehyde") can be deduced from formaldehydehydrate ($HO-CH_2-OH$) and the coenzyme which plays a role in its transmission is tetrahydro-folic acid.

The coenzyme tetrahydro-folic acid, "active formic acid", also accounts for the transmission of the formyl-group. According to the assumptions, the "active formaldehyde" is first fixed on N^{10} atoms, but easily forms a bridge with N^5 as well, and a cyclic compound is produced (Fig. 1). The most important pathway for "active formaldehyde" formation is the transformation of serine into glycine. The reaction is reversible, so serine can be formed from glycine and "active formaldehyde", as in Fig. 2.

In the reaction equation it can be seen that Schiff's base is formed from serine and pyridoxal phosphate in the first step. Due to the electron-attracting effect of the positively charged N atom of the pyridine ring mesomerism can occur, but only if the $-CH_2OH$ sub-

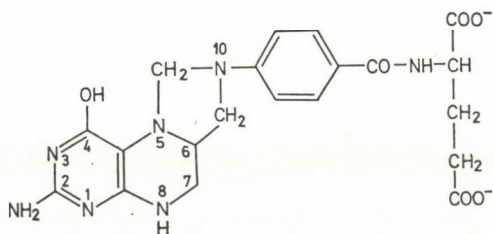
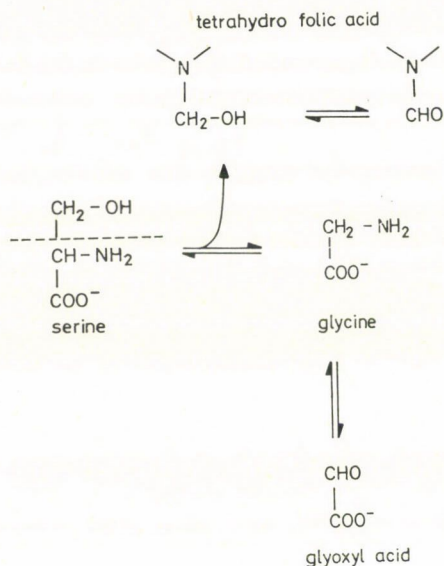
Fig. 1. N^5-N^{10} tetrahydro folic acid

Fig. 2. Formation of "active formaldehyde" from serine

stituent is eliminated from the α -carbon atom of serine; this is illustrated in Fig. 3. Then the mesomeric state is stabilized by the proton addition to the α -carbon atom, and by the hydrolysis of Schiff's base into primary amine.

Glycine and serine are the early products of glycolate metabolism. After 30 seconds, exposition labelled glycine and serine can be found in the leaves of sugar beet in a 0.1% carbon-14-dioxide field. If the carbon dioxide concentration is increased to 0.25%, the incorporation of radioactivity decreases by 68% in the two amino acids, although in phosphate esters this does not occur (MORTIMER 1959). In the 50–500 ppm concentration range of carbon-14-dioxide the percentage of carbon-14 labelling was the same in glycine and serine, but an 80% restraint could be observed in the case of 0.3% carbon dioxide concentration (TOLBERT 1963). A similar impeding effect was shown in experiments carried out on glycolate synthesis with *Chlorella* cells at a higher concentration of carbon dioxide (WARBURG—KRIPPAHL 1960). Based on these and on several other findings it can be stated that increased oxygen concentration can increase the synthesis of amino acids, but in carbohydrates it can result in a decrease.

BISHOP—WHITTINGHAM (1968) studied carbon dioxide fixation in tomato plants grown in air or in a high carbon dioxide concentration (0.1–1.0%) and found that considerable

carbon-14 was incorporated in the glycine-serine fraction at higher carbon dioxide concentrations.

The pathway of "active formaldehyde" formation can be deduced on the basis of the above facts through the amino acids serine and glycine, and thus through the glycolic acid cycle, according to the present conceptions. The biochemical pathways of glycolic acid formation have not been completely clarified yet, although this metabolite is one of the early products of photosynthesis. BENSON—CALVIN (1950) found in their experiments that glycolic acid contained 50% labelling after 15 seconds when considering carbon-14 distribution, while the labelled glycolic acid quickly disappeared from the plants in the dark.

In plants the high demand for light in the synthesis of glycolic acid and its disappearance in the dark were also observed by STUTZ—BURRIS (1951). In the plant tissues an active glycolate-oxidase system operates which considerably decreases, or completely eliminates the glycolic acid level, as glycolic acid is produced only during intensive photosynthesis and at high light intensity.

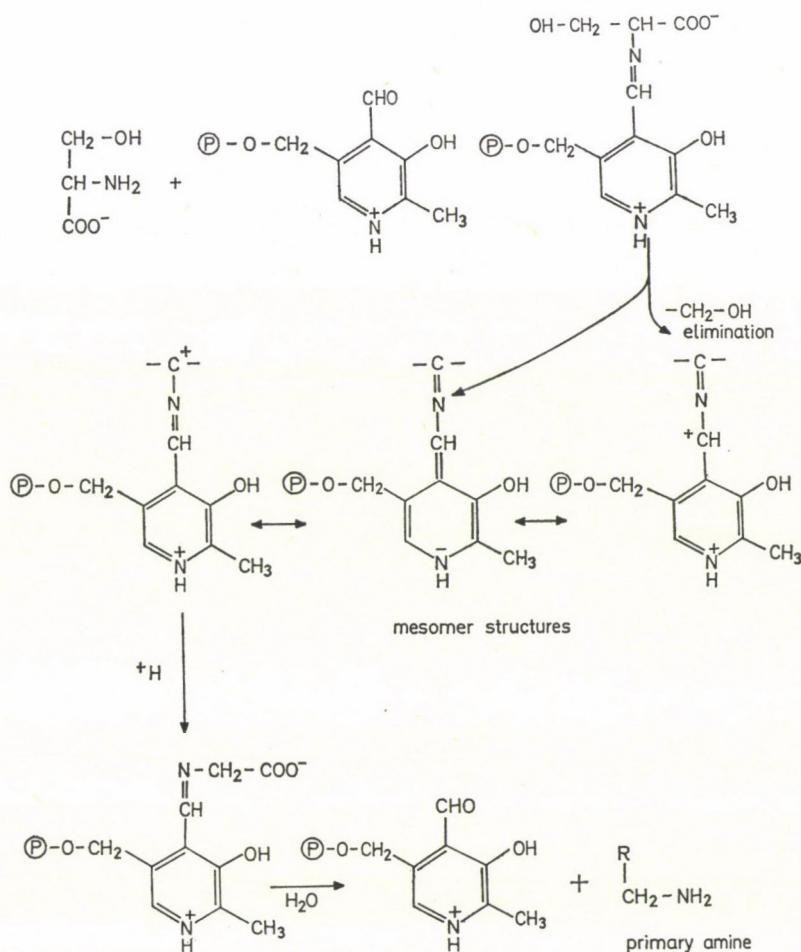


Fig. 3. Mechanism of elimination of -CH₂-OH group

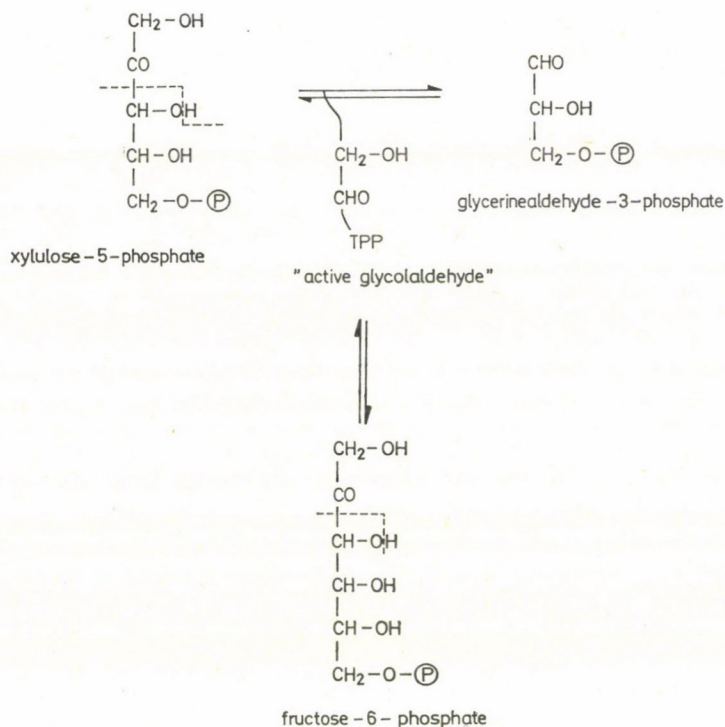


Fig. 4. Formation of "active glycolaldehyde"

During the photosynthetic fixation of carbon-14-dioxide the glycolate becomes equally labelled on both carbon atoms within 15—30 seconds, as has been observed by several investigators, although HESS—TOLBERT (1967) found in their analyses that the two-carbon atom has higher radioactivity than the carboxyl one. ZELITCH (1965, 1971) proved in experiments carried out on tobacco leaves that the specific activity of glycolic acid exceeds that of the glyceric acid-3-phosphate. ANDERSON—FULLER (1967) found that the bacterium *Rhodospirillum rubrum* incorporated 70% of the carbon-14 fixed from carbon-14-dioxide in 3 seconds into glycolic acid. In the process the percentage of radioactivity in the glycolic acid decreases, as if it were the "first product" of photosynthesis, while that of the phosphate esters increases in further periods. These results seem to confirm that glycolic acid is formed in a carboxylation process independent of the enzyme glycolic acid-diphosphate-carboxylase, which has not been discovered so far.

The synthesis of glycolic acid in the light is stimulated by increasing the concentration of molecular oxygen. After 3 minutes the quantity of carbon-14 measured in the glycolic acid during carbon-14-dioxide fixation is 5% of the quantity added in the absence of molecular oxygen, while it reached 10% in a 20% oxygen atmosphere, and 38% with a 100% content of molecular oxygen.

It should be noted that the data concerning the formation of glycolic acid are in several cases divergent; a number of results prove the formation of glycolic acid in photorespiration (ZELITCH 1968, KIASKI—TOLBERT 1970, JACKSON—VOLK 1970, DECKER 1970 and others).

The formation of "active glycolaldehyde" was shown in a model system (Fig. 4) in the Calvin-cycle; in the transketolase reaction (enzyme containing thiamine-pyrophosphate) it

catalyses the transfer of C_2 from convenient compounds, e.g. from xylulose-5-phosphate, from ribulose-5-phosphate or from fructose-6-phosphate. In the absence of the acceptor the "active glycolaldehyde" is bound to the thiazole ring of thiamine.

For the addition of glycolaldehyde and glycolaldehyde-phosphate BALDRY *et al.* (1966) and O'NEAL *et al.* (1972) observed that the photosynthesis of carbon-14-dioxide significantly decreased by about 30—90%. Similarly, SCHACTER *et al.* (1971) showed a decrease in glycolic acid during photosynthesis due to the effect of adding fructose-1,6-diphosphate. The latter results seem to support the fact that photosynthetically fixed carbon dioxide can also be incorporated through glycolaldehyde (SZARVAS—POZSÁR 1979).

On evaluating all these experimental data a question arises: Is it possible that glycolaldehyde is produced from a C_1 primary compound, i.e. by the reduction of carbon dioxide to formaldehyde, and can this be experimentally proved? The present experiments were an attempt to prove this in a direct way.

The experiments were carried out on maize (*Zea mays* L. Mv-5 single cross hybrid) seedlings. For detecting the endogenous, free formaldehyde, maize plants were taken from the soil together with the roots, then washed and placed into an aqueous solution of 0.4% dimedone (5,5-dimethyl-cyclohexane-1,3-dione). After the required period of uptake (generally 4 hours) the plants were fixed with liquid air, disintegrated and extracted with 25 ml of diethyl ether. The extracts were concentrated to a volume of 0.5 ml, then the whole solution was spotted onto a silica gel layer containing fluorescent material* and a chromatogram was made in a 99.5 : 0.5 mixture of benzene and methanol. After drying, the thin layer chromatograms were evaluated under a UV-lamp. The formaldehyde-dimedone derivative was well separated from the other materials of the plant extract. In the first step the derivative was identified by simultaneously running a formaldehyde-dimedone standard, and the reaction carried out by TYIHÁK (1978) with dichloro-quinone-chloroimide was also used, which is specific for formaldehyde-dimedone. During separation two more aldehyde-dimedone derivatives were identified on the thin layer; these proved to be glycerine-aldehyde-dimedone and glycolaldehyde-dimedone, respectively. For careful identification the aldehyde derivatives were rubbed off the layer and evaluated, after which the chromatographic separation was repeated.

In order to explain the conditions during the formation of the free formaldehyde, glycolaldehyde and glycerine-aldehyde detected with the dimedone reaction, the following experiments were carried out:

1. Carbon dioxide fixations were performed for short and long periods using carbon-14-dioxide.
2. In vivo experiments were carried out using dimedone labelled with carbon-14 and tritium. The formaldehyde and other aldehyde derivatives were also identified with the help of standard aldehyde derivatives produced by applying radioactive dimedone.
3. In vivo experiments were performed applying carbon-14-formaldehyde and tritiated formaldehyde, the appearance of radioactive dimedone derivatives was studied using inactive dimedone, and the distribution of radioactive formaldehyde was examined.
4. Experiments were carried out with formic acid labelled with carbon-14 and tritium, also under in vivo conditions.
5. In vivo experiments were carried out using d-glucose generally labelled with carbon-14 isotope to decide whether labelled formaldehyde-dimedone or other dimedone derivatives can be detected that would indicate the formation of formaldehyde and the other aldehydes by photorespiration.

* DC-Plastikrolle Kieselgel F 254, Merck

6. Experiments were set up for the determination of photolytic activity using tritiated water.

7. D-glucose was separated after the photolytic decomposition of HTO for its quantitative determination.

1. Experiments on carbon-14-dioxide assimilation

Carbon dioxide was fixed in long period light and dark in the apparatus illustrated in Fig. 5. The analyses were carried out with maize seedlings pretreated with dimedone as described above. Before the experiments the apparatus was exhausted with the S-stopcocks in the proper positions, then stopcocks S_4 and S_8 were turned off and carbon-14-dioxide was produced in part A of the apparatus from previously dispensed barium- ^{14}C -carbonate (40.7 MBq) and lactic acid, and this was frozen in trap Cs_1 with liquid air. After quantitative freezing stopcock S_5 was turned off, the gas generator was removed and a dish containing plants pretreated with dimedone was put in its place. In the short period experiments (Fig. 6) the carbon-14-dioxide gas was in contact with the plants for 10, 30 and 60 seconds. This could be achieved in the following way: the air was exhausted from the dish holding the plants, carbon-14-dioxide was allowed to expand from trap Cs_1 and, having opened stopcock S_5 , it was let onto the plants. Immediately after the exposition time the system was exhausted and the plants were frozen with liquid air. In long period experiments the carbon dioxide expanded

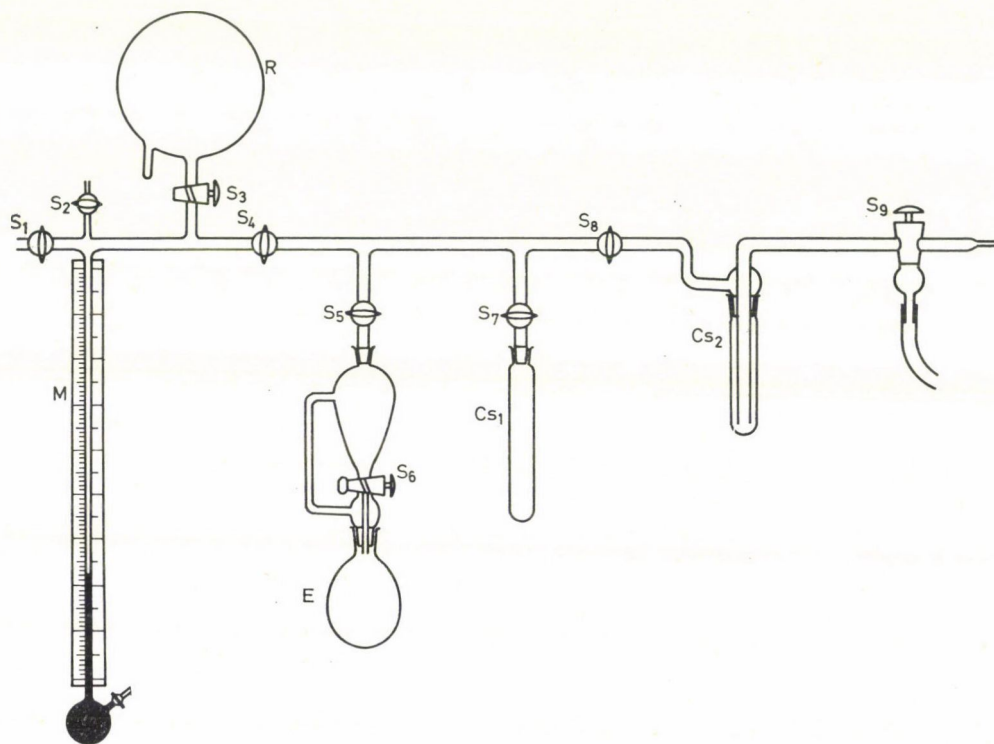


Fig. 5. Apparatus for generation of carbon-14-dioxide. M: manometer, S_1 — S_9 : stopcocks, reservoir for $^{14}\text{CO}_2$, Cs_1 : trap for $^{14}\text{CO}_2$, Cs_2 : trap for retrodiffusion, E: tube for generation of $^{14}\text{CO}_2$

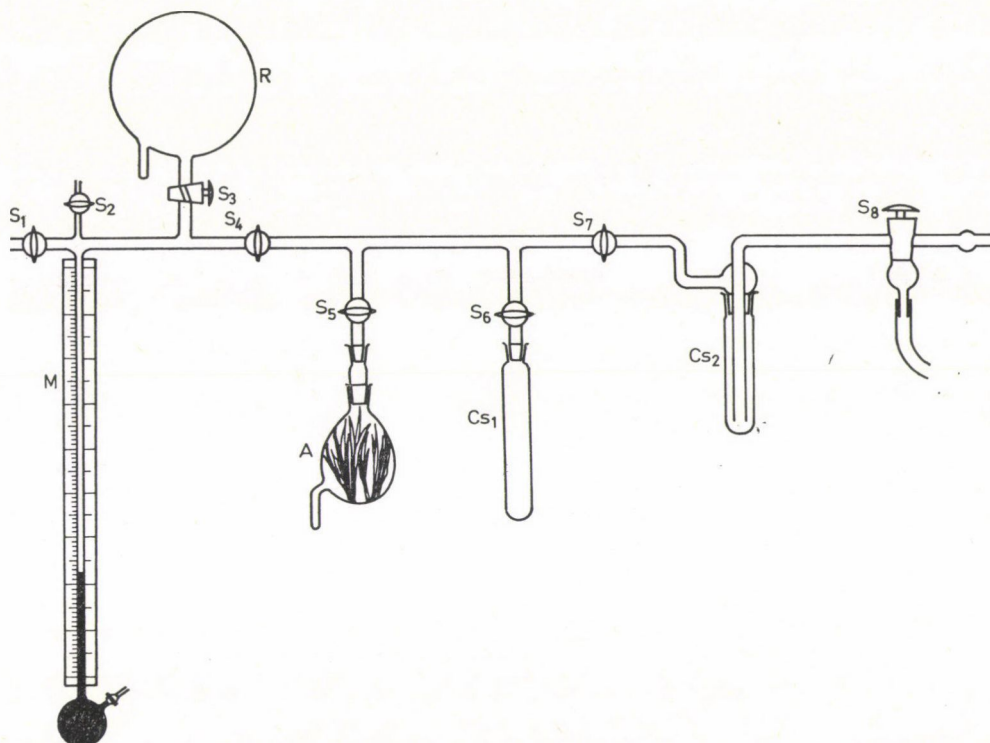


Fig. 6. Apparatus for photosynthetic carbon-14-dioxide fixation. M: manometer, S_1 — S_8 : stopcocks, Cs_1 : trap for $^{14}CO_2$, Cs_2 : trap for retrodiffusion, R: reservoir, A: tube for placing the seedlings

from trap Cs_1 was first frozen in a small trap in dish A, then it was allowed to expand and was kept on the plants for an hour. Comparative measurements were carried out in the light (about 5000 lux) and in the dark. Any radioactive gas not used up was fixed in alkaline absorber in the assays. In this apparatus it was possible to perform experiments in such a way that the glass recipient E was first filled with carbon-14-dioxide, then the manometrically measured carbon dioxide was used in the experiments in the way outlined above.

After carbon dioxide fixation the plants were taken out of the apparatus, fixed with liquid air and then extracted with 3×15 ml diethyl ether. After concentrating the extracts they were chromatographed in the way described above, the dimedone derivatives were identified and the radioactivity distribution on the chromatographs was determined with a Berthold thin-layer chromatogram scanner; the formaldehyde-dimedone, glycolaldehyde-dimedone and glycerine-aldehyde-dimedone spots labelled with carbon-14 were rubbed and extracted and the radioactivity of the liquids was measured in a liquid scintillation spectrometer (Berthold BF 5000 and Packard Tricarb 3390).

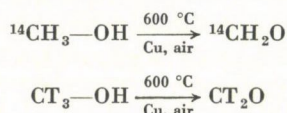
2. Experiments with dimedone labelled with carbon-14 and tritium

Endogenous and free formaldehyde, glycolaldehyde and glycerine-aldehyde were also detected by using dimedone labelled with carbon-14 and tritium. The experiments proceeded in the same way as with inactive dimedone. For this, dimedone labelled with carbon-14 and tritium was produced, the specific activity was determined and after the radiochemical purity of the substances was checked they were used in the experiments.

3. Experiments with formaldehyde labelled with carbon-14 and tritium

In these assays an aqueous solution of formaldehyde labelled with carbon-14 and tritium was taken up by maize seedlings for four hours, then the plants were washed and placed in a 0.4% aqueous dimedone solution. After four hours the plants were fixed with liquid air, disintegrated and extracted with diethyl ether. After this, chromatographic analyses were performed in the manner described above. The dimedone derivatives of formaldehyde, glycolaldehyde and glycerine-aldehyde were identified and their radioactivity was determined. The experiments — with the exhaustions in reverse order — were carried out in the same way as those described above.

Formaldehyde labelled with carbon-14 and tritium was produced from labelled methanol on a copper oxide catalyst by partial oxidation in accordance with the following equation:



For this a mixture of 10 mM (0.320 g) methanol labelled with carbon-14 and tritium, and water of the same quantity was led through a freshly made, large surface Cu-catalyst in a slow air flow at a temperature of 600°C. The formaldehyde obtained was absorbed in 1 ml of distilled water in two absorption traps connected successively.

4. Experiments with formic acid labelled with carbon-14 and tritium

Formic acid labelled with carbon-14 and tritium was taken up by another group of maize seedlings for four hours. In the experiments 10 plants were emersed in a 0.256% formic acid solution with 37.0 MBq total activity. After uptake the plants were placed in a 0.4% aqueous dimedone solution for four hours, then the samples were processed for the analyses as detailed above.

5. Experiments with d-glucose generally labelled with carbon-14

In these experiments an aqueous solution of labelled d-glucose was taken up by maize seedlings for four hours, followed by a 0.4% aqueous solution of dimedone. Uptake proceeded in the reverse order as well. After exposure the plants were fixed with liquid air and following extraction with diethyl ether the chromatographic analyses described above were carried out.

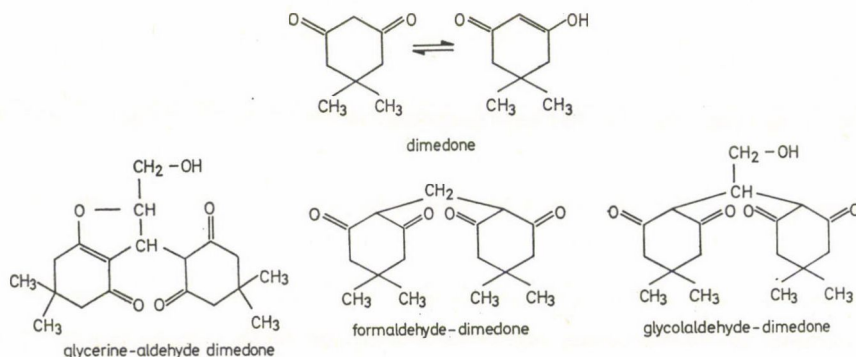


Fig. 7. Structure of aldehyde-dimedone derivatives

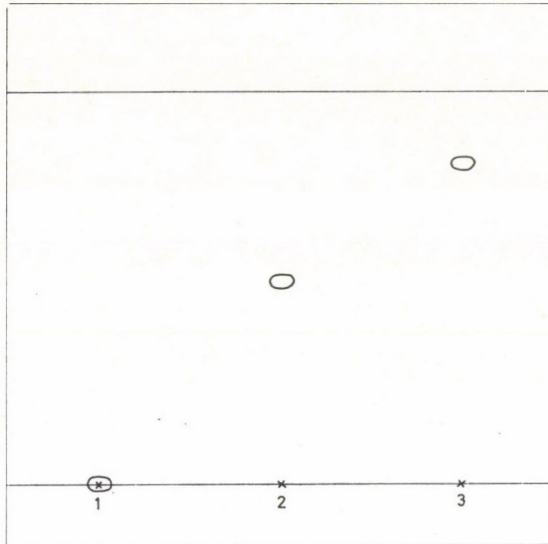


Fig. 8. Separation of formaldehyde-dimedone, glycerine-aldehyde-dimedone and glycol-aldehyde-dimedone Silica gel layer: DC-Plastikrolle, Kieselgel F 254 MERCK. Mixture: benzene : methanol, 99.5 : 0.5. Rf values: 1. glycerine-aldehyde-dimedone STANDARD: 0.0; 2. formaldehyde-dimedone STANDARD: 0.52; 3. glycolaldehyde-dimedone STANDARD: 0.80

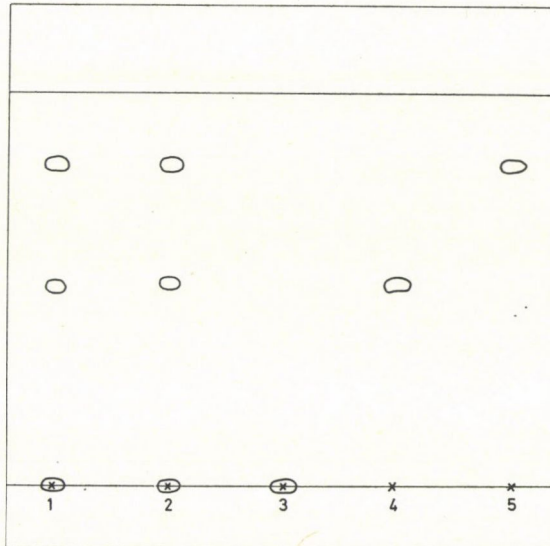


Fig. 9. Separation of aldehyde-dimedone derivatives from diethyl ether extracts of maize seedlings. Silica gel layer: DC-Plastikrolle, Kieselgel F 254, MERCK. Mixture: benzene : methanol 99.5 : 0.5 1. plant extract (treated with inactive dimedone); 2. plant extract (treated with dimedone ^{14}C and ^3H); 3. glycerine-aldehyde-dimedone STANDARD, Rf: 0.0; 4. formaldehyde-dimedone STANDARD, Rf: 0.52; 5. glycolaldehyde-dimedone STANDARD, Rf: 0.80

6. Experiments with HTO to determine photolytic activity

The formation of tritiated formaldehyde and tritiated d-glucose was studied in connection with photolysis by the uptake of tritiated water (HTO). After four hours' uptake of inactive dimedone and one hour's exposure to tritiated water (HTO) the samples were fixed by means of liquid air. The incorporated radioactivities were determined in the formaldehyde and d-glucose fractions after the chromatographic separation which is described in the following section.

7. Experiments carried out after the photolytic decomposition of HTO for the quantitative determination of d-glucose

For the determination of d-glucose the plant material was frozen with liquid air, disintegrated and extracted with 80% ethyl alcohol. The extracts were made free of solvent on a rotary evaporator at a temperature of 35°C. Chlorophyll was dissolved with diethyl ether, after which the residue of evaporation was dissolved in distilled water and the pH was adjusted to 2.0–2.5 with the help of 0.5 N acetic acid. Then the solution was poured onto Dowex 50 H⁺ ion-exchange resin. After shaking for a quarter of an hour it was decanted and the resin was washed with 10 ml of 0.5 N acetic acid. The solution containing d-glucose (and also other sugars) and organic acids was concentrated on a rotary evaporator and then dissolved with 3 ml of 80% ethyl alcohol. 3.0 ml ethyl alcohol extract was chromatographed on a cellulose MN 300 thin layer in a 4 : 1 : 5 mixture of butanol : acetic acid : water. After a second running proper separations could be obtained. The 5 : 5 : 1 mixture of 4% aniline : 4% diphenyl amine : concentrated phosphoric acid was applied as developing reagent. After spraying the layers with developer they were dried at a temperature of 85°C for 45 minutes. Spots containing glucose were rubbed off the layer, then dissolved with 80% ethyl alcohol. The radioactivity was determined by the liquid scintillation method in a Berthold BF 5000, Packard Tricab 3390 liquid scintillation spectrometer.

The presence of endogenous, free formaldehyde in maize leaves has been proved beyond doubt by *in vivo* experiments carried out with inactive and radioactive dimedone. It can be directly demonstrated by chromatographic analyses.

The structural formulae of the applied dimedone reagent and the examined aldehyde derivatives (formaldehyde-dimedone, glycolaldehyde-dimedone and glycerine-aldehyde-dimedone) can be seen in Fig. 7. Dimedone reacts easily with aldehydes, and can be well identified during the formation of derivatives. The reaction of dimedone is especially rapid and quantitative in *in vitro* experiments with formaldehyde. In Fig. 8 the chromatogram shows the position of dimedone derivatives of the three aldehydes. It can be seen that in the system applied the aldehyde derivatives are well separated from one another. In Fig. 9 the chromatogram shows the position — after the simultaneous running of standards — of the dimedone derivatives of the aldehyde isolated from the plant extract. It should be noted that the dimedone derivatives fluoresce very intensively under a UV lamp, so they can be detected even in very small concentrations. 0.1 µg of formaldehyde-dimedone gives a distinctly visible fluorescent spot.

The *in vivo* formation of formaldehyde-dimedone has been justified by both standard inactive and radioactive dimedone derivatives, while their chemical identity was demonstrated by chromatographic separation and radioactivity measurements on the spot corresponding to formaldehyde-dimedone after the uptake of formaldehyde-¹⁴C into the leaves (Table 1). So radioactive formaldehyde was applied as an internal standard. The presence of the other two aldehydes appearing in *in vivo* experiments was proved in a similar way. After *in vivo* dimedone assays the following question remained: Can the endogenous, free formaldehyde be

Table 1

*Distribution of carbon-14 radioactivity
in the dimedone derivatives of aldehydes
(formaldehyde-dimedone, glycolaldehyde-dimedone
glycerine-aldehyde-dimedone) after the $^{14}\text{CH}_2\text{O}$
treatment of maize seedlings*

Aldehyde-dimedone derivatives	Distribution of carbon-14	
	kBq	%
Formaldehyde	7506.75	95.58
Glycolaldehyde	50.06	0.64
Glycerine-aldehyde	296.96	3.78

brought into connection with the early processes of photosynthesis? This question can be answered best by the results of photosynthetic fixation experiments carried out with carbon-14-dioxide.

It is known that in short period fixation studies only glyceric acid-3-phosphate was found to be exclusively radioactive by CALVIN—BASSHAM (1962), while ribulose-1,5-diphosphate was assumed to be responsible for carbon dioxide fixation mainly on the basis of other assays using paper chromatography. It was shown in cell-free preparations that ribulose-1,5-diphosphate-carboxylase (i.e. carboxy-dismutase enzyme) carries out the carboxylation reaction and the formation of a six-carbon-atom intermediate was assumed. In spite of intensive investigations this six-carbon-atom product could not be detected. Furthermore, the isolated enzyme preparation was not found to be active enough to serve as an explanation for the extent of carbon dioxide fixation, i.e. for the considerable accumulation of organic materials under field conditions.

It was also acknowledged by CALVIN—BASSHAM (1962) that under the given experimental conditions intermediates must have been present that were unstable or volatile, as a consequence of which they could not be isolated. It is also known that in their experiments the short period fixations were carried out in such a way that photosynthesis was interrupted after the chosen period by placing the material to be examined in hot alcohol. In the studies consideration was given to the possible presence of an intermediate that occurs in such a small concentration that it could not be detected by the methods available. This possibility could not be excluded, particularly if it was the most active intermediate, as its transformation would then be very rapid, so it could only ever be present in very small concentrations.

In the opinion of the authors this has been proved by the occurrence of endogenous and free formaldehyde, which was definitely shown in the experiments. As can be seen in Table 2, a small but definite extent of radioactivity appears even after 10 seconds' fixation. So formaldehyde is obviously a product of photosynthetic origin. The fact that glycolaldehyde becomes radioactive shows that under the given experimental conditions it can be produced only by transformation from formaldehyde. In this way there was no possibility for the formation of glycolaldehyde on the basis of the conceptions which existed previously. From earlier studies it was concluded that glycolic acid and glycolaldehyde are produced at a high oxygen and low carbon dioxide concentration. In the present experiments the glycolaldehyde was produced from formaldehyde under reverse conditions, as carbon dioxide fixation proceeded practically in the absence of oxygen and at a very high carbon dioxide concentration. The equal distribution of radioactivity in the C_2 product was explained by TOLBERT (1963) as being produced from glyceric acid-3-phosphate under the hydrolytic effect of a chloroplast-

specific phosphatase. BASSHAM's (1963) theory was that the C_2 products can be deduced from thiamine-pyrophosphate-glycolaldehyde adduct, that is in connection with the transketolase reaction of the Calvin-cycle. So far this enzyme has only been detected in bacteria, not in higher plants. It should be underlined that in the authors' opinion the very small extent of incorporation in the aldehyde derivatives — compared to the concentration applied — can be explained by the fact that the transformation of formaldehyde and the other aldehydes proceeds at a higher rate than the reaction with the exogenous acceptor, dimedone. Only a fraction of the formaldehyde, glycolaldehyde and glycerine-aldehyde being formed can be isolated by the dimedone added. Among the reactions proceeding between the three aldehydes and dimedone, that with formaldehyde has the highest reaction rate. For this reason the measured carbon-14 activities only differ to a small extent. This is because, due to rapid transformation as a consequence of the lower reaction rate of the dimedone reaction, less can be isolated from glycolaldehyde and glycerine-aldehyde in the chromatographic analyses. Despite this, in the long period experiments (Table 2) obviously higher incorporation can be detected in the glycerine-aldehyde-dimedone derivatives, although the possibility of the metabolic pathways mentioned earlier cannot be excluded here. The results of experiments carried out on formaldehyde (labelled with carbon-14) uptake show (Table 1) that there is a strong connection between the three aldehydes. The glycolaldehyde and the glycerine-aldehyde were also labelled from the formaldehyde after a 4 hour period. Although this can be considered as a long period experiment, the "primary characteristic" of formaldehyde is confirmed

Table 2

Distribution of radioactivity in the formaldehyde-dimedone, glycolaldehyde-dimedone and glycerine-aldehyde-dimedone derivatives after 10 seconds and one hour of carbon-14-dioxide fixation

Dimedone derivatives	Radioactivity in Bq	
	10 sec	1 hour
Formaldehyde-dimedone	8.16	71.66
Glycolaldehyde-dimedone	11.16	55.80
Glycerine-aldehyde-dimedone	11.92	104.16

Table 3

Transformation of formic acid ($H^{14}COOH$) labelled with isotope carbon-14 into formaldehyde, glycolaldehyde and glycerine-aldehyde (the aldehyde-dimedone derivatives were analysed after 4 hours' formic acid uptake and a subsequent 4 hours' 0.4% dimedone uptake)

Aldehyde-dimedone derivatives	Radioactivity in kBq
Formaldehyde-dimedone	42.550
Glycolaldehyde-dimedone	31.820
Glycerine-aldehyde-dimedone	86.765

by these data, too, in the short period experiments. This is because the radioactivity of glycolaldehyde and glycerine-aldehyde can be derived from formaldehyde.

Table 3 and Fig. 10 show the results of experiments carried out with formic acid labelled with carbon-14. From the chromatographic analysis of the diethyl ether extract it

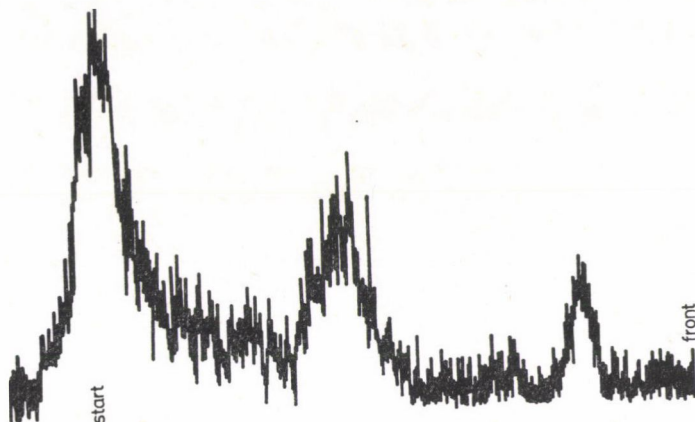


Fig. 10. Distribution of radioactivity of the diethyl ether extract of maize seedlings after treatment with dimedone, and treatment with $H^{14}COOH$. Silica gel layer: DC-Plastikrolle, Kieselgel F 254, MERCK. Mixture: benzene : methanol 99.5 : 0.5

can be seen that a considerable amount of radioactivity is incorporated in the formaldehyde from the formic acid. This definitely justifies the assumption that the formation of formic acid is not negligible in the first step of the carbon dioxide reduction. This has not yet been demonstrated experimentally, but tests are now being carried out. At any rate, it can be stated without doubt that the transformation of carbon-14-formic acid proceeds via *in vivo* formaldehyde in maize seedlings, which is another proof of the occurrence of free formaldehyde in living plant (leaf) tissues. Similar results were obtained with tritiated formic acid (Table 4).

Studying the *in vitro* exchange of tritium between inactive formaldehyde and HTO, the data in Table 5 show that the exchange measured was six orders of magnitude lower than for bioenergetic photolytic decomposition, so this is a negligible value.

Table 4

Transformation of tritiated formic acid (3HCOOH) into formaldehyde, glycolaldehyde and glycerine-aldehyde (The aldehyde-dimedone derivatives were analysed after 4 hours' formic acid uptake and a subsequent 4 hours' 0.4% dimedone uptake)

Aldehyde-dimedone derivatives	Radioactivity in kBq
Formaldehyde-dimedone	52.150
Glycolaldehyde-dimedone	41.920
Glycerine-aldehyde-dimedone	96.860

Table 5

Exchange of hydrogen with tritium in formaldehyde-dimedone in the presence of HTO and formation of tritiated formaldehyde due to the photolytic decomposition of HTO under the effect of the inactive dimedone taken up, after one hour's exposition

Tritiated compounds	Radioactivity in kBq/mol values
Exchange of inactive formaldehyde-dimedone and HTO, in model	2.2×10^4
Tritiated formaldehyde-dimedone formed by the photolytic decomposition of HTO	2.2×10^{10}
Exchange of inactive formaldehyde-dimedone and HTO, in model	
1. in kBq	0.0000022
2. as a % of photolytic activity	0.0005

Table 6

Radioactivity of formaldehyde-dimedone in the diethyl ether extract of maize seedlings after uptake of d-glucose generally labelled with carbon-14

Dimedone derivative	Radioactivity in Bq
Formaldehyde-dimedone	0.63
Background	0.58

Table 7

Incorporation of carbon-14 into aldehyde-dimedone derivatives during carbon-14-dioxide fixation in consequence of monobromo acetic acid restraint in short period (10 seconds) and long period (one hour) experiments. Treatment with monobromo acetic acid of 1000 ppm was carried out in long period exposition

Dimedone derivatives	Radioactivity in Bq	
	10 sec	1 hour
Formaldehyde-dimedone	5.6	24.6
Glycolaldehyde-dimedone	9.3	61.6
Glycerine-aldehyde-dimedone	13.0	63.3

It is known that when CALVIN—BASSHAM (1962) studied the distribution of carbon-14-isotope in glyceric acid-3-phosphate they found that after four seconds the carboxyl group showed the highest radioactivity, while the other two carbon atoms showed an equal but considerably lower amount of radioactivity. After 60 seconds the radioactivity of the carboxyl group was only 10% higher than that of the other two carbon atoms. This indicates that C₂ and C₃ of glyceric acid-3-phosphate obtained their radioactivity not directly from carbon

Table 8

Radioactivity of tritiated compounds formed by HTO photolysis in one hour's exposition after the separation of formaldehyde-dimедone and d-glucose, together with the radioactivity of the other metabolites left. The % values of the fractions are related to the total radioactivity

Compounds (fraction)	Radioactivity kBq/g fresh weight	% value of fractions related to radioactivity
Formaldehyde	147.48	50.1
D-glucose	71.18	25.1
Other intermediates	70.70	24.8

Table 9

Incorporation of isotope carbon-14 into the formaldehyde-dimедone derivatives in the light and in the dark, in carbon-14-dioxide fixations during long period (one hour) exposition

Dimedone derivative	Radioactivity in Bq	
	in the light	in the dark
Formaldehyde-dimедone	869.8	101.27

Table 10

Formation of tritiated formaldehyde-dimедone and d-glucose during the photolytic decomposition of HTO in the light and in the dark. The table gives the radioactivity in kBq/g fresh weight with the %-value of the compounds formed in the dark, related to the data measured in the light in long period (one hour) exposition

Tritiated compounds	Radioactivity kBq/g fresh weight		Tritiation in the dark as a % of tritiation in the light
	in the light	in the dark	
Formaldehyde-dimедone	271.11	174.16	64.2
D-glucose	261.07	189.88	72.7

dioxide but through a "cyclic process". If the primary formation of formic acid can be proved in carbon dioxide fixation experiments, it would seem that the formation of glyceric acid-3-phosphate could be achieved by the combination of one molecule of formic acid and two molecules of formaldehyde. This is confirmed by the high radioactivity of the glycerine-aldehyde-dimedone derivative appearing at the start in Fig. 10 in experiments carried out on the uptake of formic acid labelled with carbon-14.

In the present studies it became necessary to decide whether labelled formaldehyde can be produced in photorespiration processes in long period experiments. For this reason d-glucose generally labelled with isotope carbon-14 was taken up by maize seedlings, followed by a 0.4% aqueous solution of dimedone. Uptake progressed in the reverse order as well. During the analysis of the formaldehyde-dimedone derivative no radioactivity could be found in formaldehyde-dimedone (Table 6), proving that endogenous, free formaldehyde and the radioactive formaldehyde formed in the experiments described above are not the products of photorespiration processes. In long period experiments (one hour) carbon dioxide fixations were carried out, where the plants were previously kept in 1000 ppm solution of monobromo acetic acid for four hours, then in 0.4% dimedone, again for four hours. The radioactivity of the examined aldehyde-dimedone derivatives in the plant extract after carbon dioxide fixation can be seen in Table 7. The distribution of activity shows that monobromo acetic acid hinders the Calvin-cycle and the Hatch—Slach pathway, so the transformation of glycolaldehyde and glycerine-aldehyde is also hindered, as can be observed from the practically identical values of radioactivity. The impeding effect of monobromo acetic acid forces formaldehyde to follow other pathways.

The data in Table 8 were obtained after the long period (one hour) photolysis of HTO with a previous four-hour uptake of 0.4% dimedone. The formaldehyde-dimedone was isolated in the first sample and the d-glucose in the second sample using the chromatographic method described above. The total radioactivity was determined in the third sample. In this way the higher level of endogenous and free formaldehyde — compared to the long period fixations — could be clearly evaluated, together with the fact that the quantitatively produced formaldehyde is not fixed at all by the dimedone added.

It can be seen from the data in Table 9 that in long period (one hour) exposition the ratio of formaldehyde-dimedone formed during carbon-14-fixation in the light and in the dark corresponds to that determined in previous experiments with d-glucose.

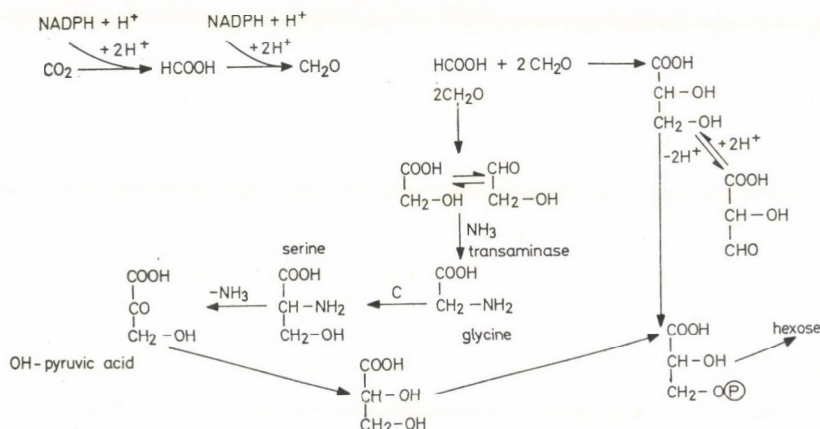


Fig. 11. Transformation of formaldehydes into the glycolate metabolism and the Calvin-cycle

According to the data in Table 10 the ratio of tritiated formaldehyde and tritiated d-glucose produced in the light and in the dark differs considerably from the results obtained in long period fixation of carbon-14-dioxide (Table 9). Tritiated formaldehyde, originating from the photolytic decomposition of HTO, and tritiated d-glucose are formed in a relatively higher amount.

Taking into consideration all these experimental results, Fig. 11 presents a new pathway for formaldehyde \rightarrow glycolate carbon fixation in the early period of carbon fixation, that can be directly connected with the Calvin-cycle.

*

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USE OF MICROPHOTOMETRY FOR HISTOCHEMICAL STUDIES ON THE CELL WALLS OF LATICIFERS IN *PAPAVER SOMNIFERUM* L.

Among other investigations of a biological nature, the development of laticifers in *Papaver somniferum* L. was the subject of many poppy experiments in Hungary in the 1950ies (LASSÁNYI 1957). Due to improvements in the methods, studies on the laticifers of *Papaver somniferum* L. have lately come into prominence again (NESSLER—MAHLBERG 1976, 1977a, b). The present paper contributes to knowledge on the laticifer system of the poppy with a microphotometric analysis of the histochemical composition of cell walls in the laticifers.

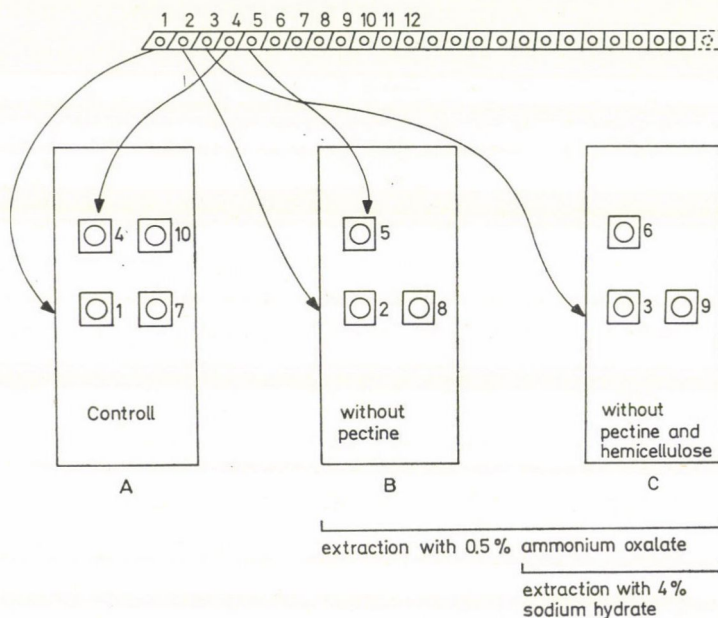


Fig. 1. Removal of carbohydrates from the cell wall according to Jensen

For the analyses, specimens of the varieties Japanese B, Kleinwanzlebener and Spanish, and of the F_1 hybrids of Japanese B \times Spanish and Japanese B \times Kleinwanzlebener were used. Five opium-ripe main capsules of each variety and hybrid were analysed in the preliminary examinations and three in the study itself. The plants were chosen from among those grown in the experimental plots of the Research Institute for Medicinal Plants at Budakalász. The sowing date was 23rd September 1977, and the fixing date 12th June 1978.

A 0.5 cm section from the middle of each opium-ripe main capsule was fixed. The fixation was carried out in 3% glutaraldehyde at 0°C, according to FEDER—O'BRIEN (1968). Embedding in paraffin took place by the usual microtechnical procedure after dehydration with tertiary butyl alcohol (JOHANSEN 1940). 13 μ m sections were prepared from the material. Some were stained with a 0.2% solution of toluidine blue, and a mixture of equal ratios of 2% potassium iodide and 2% potassium ferric(III)-cyanide was used to induce chelate formation; this is a modification of the method of ROMHÁNYI (1968). The order in which the remainder of the sections were arranged is seen in Fig. 1. They were mounted, and the cell wall components dissolved in 0.5% ammonium oxalate and 4% sodium hydrate at 90°C or at room temperature; then the cell walls were stained with periodic acid-Schiff reagent (PAS) according to JENSEN (1962), with the difference that the sections were kept for 8 hours in each solution after dissolution. The sections were mounted in Canada balsam. The preparations were studied with a Reichert Zetopan research microscope. Measurements were carried out at 540 nm, with a 40 \times objective, a 12.5 \times ocular and a diaphragm 0.5 mm in diameter. In each cross-section the cell walls of 5 laticifers in the main placental bundle were measured in 4 places where anastomosis was not found. In addition, measurements were carried out in 3 places in each section where the cell walls were broken at the anastomosis. The data were statistically evaluated (SVÁB 1973). Absorption was determined by the formula $A = 1 - T$, where A = absorption, T = transmission.

NESSLER—MAHLBERG (1976, 1977a, b) demonstrated in poppy and VERTREES—MAHLBERG (1978) in *Cichorium intybus* that the cell walls of laticifers were relatively thick at the points of perforation, and that in thicker sections the cell walls were darker than those of the surrounding cells. The same was found in other investigations (Figs 2, 3), so it was considered worth employing histochemical methods for studying in more detail the composition of the cell walls in laticifers.

PAULSEN *et al.* (1978) studied the polysaccharides in the cell walls of poppy capsules with traditional chemical methods; with such methods, however, more precise information on the ratio of components in the walls of different types of cells cannot be obtained.

It is known that ammonium oxalate forms chelates with pectins and can thus be extracted from the cell wall, while hemicellulose can be removed with low concentration alkali. The residue is known as α -cellulose. All three components of the cell wall are heterogeneous (COOK—STODDART 1973). Under standard conditions a comparative analysis can determine the interrelation between these components. JENSEN—ASHTON (1960) were the first to give an account of analyses on onion root tips. They visually evaluated the differences in colour shown by the components on dissolution. This method has been made more objective by using a microphotometer and has been applied successfully, for example in evaluating the effects of herbicides (LASSÁNYI—GACSÓ 1977), and in studying the cell walls of the glandular hair of camomile (*Matricaria chamomilla*) (LASSÁNYI 1977). The present publication reports on another application of this well-proved method.

In the cell wall extract the components may be present in varying proportions, and this is influenced among other things by the state the cells are in (COOK—STODDART 1973); consequently, in the present investigations exclusively opium-ripe capsules were used in which the cambium of the vascular bundles was no longer active but the phloem cells had not yet been lignified, according to the evidence of the toluidine blue staining.

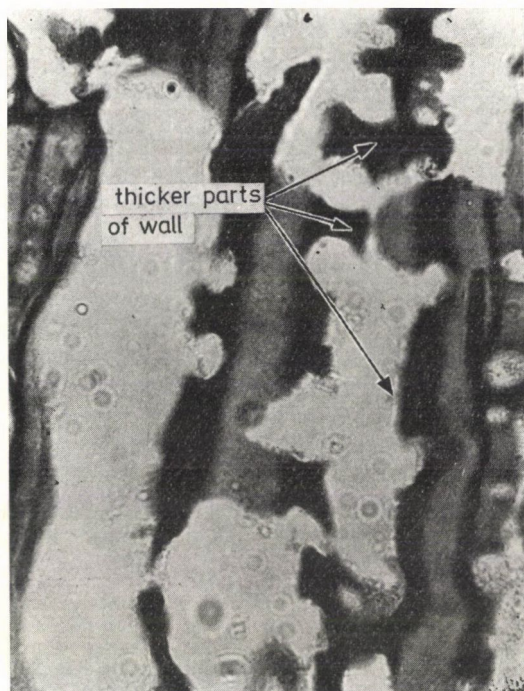


Fig. 2. Longitudinal section of the placental main bundle in the middle of the capsule wall. Anastomoses of laticifers. (Toluidine blue staining, $630\times$)

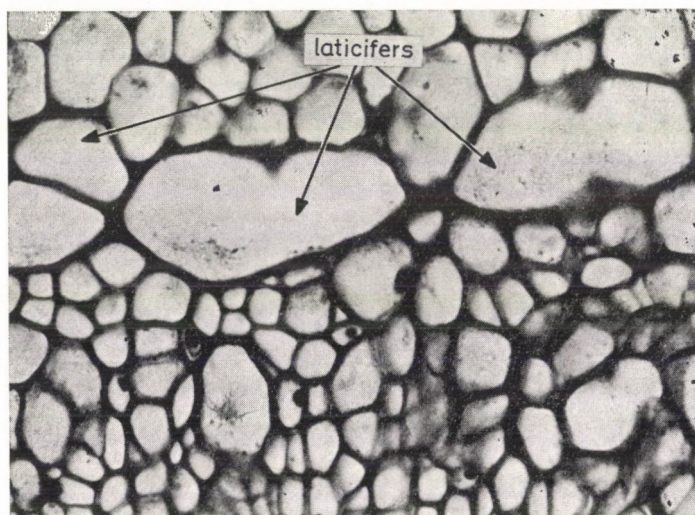


Fig. 3. Cross-section of the placental main bundle in the middle of the capsule wall. (Toluidine blue staining, $400\times$)

It should be noted here that during the embedding in paraffin the lipids of the cell wall and the phenols are dissolved, so this method cannot be used to determine the quantities of these compounds. After the pectine substances have been removed, the absorption of the cell wall does not show any significant change. The situation is different after the release of the hemicelluloses, because the cell wall then becomes visibly thinner (Figs 4, 5); this is also reflected by the changed light-absorption ability. In the preliminary study an answer was sought to the question of whether there is any difference between the examined varieties and

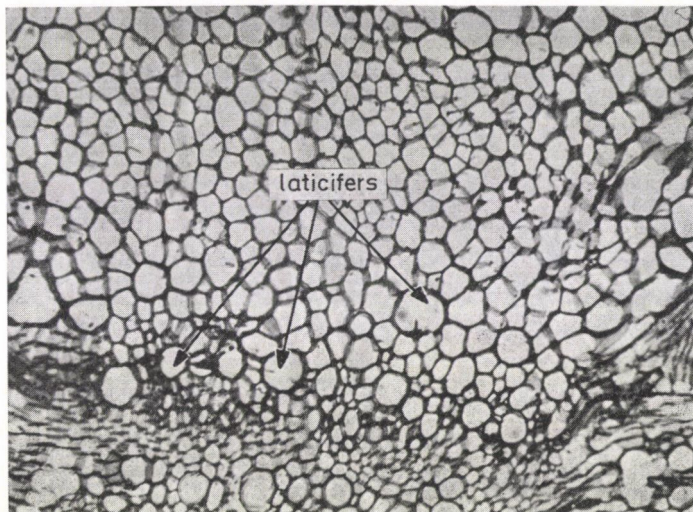


Fig. 4. Cross-section of the placental main bundle of the capsule wall. (Without extraction, PAS staining, 252 \times)

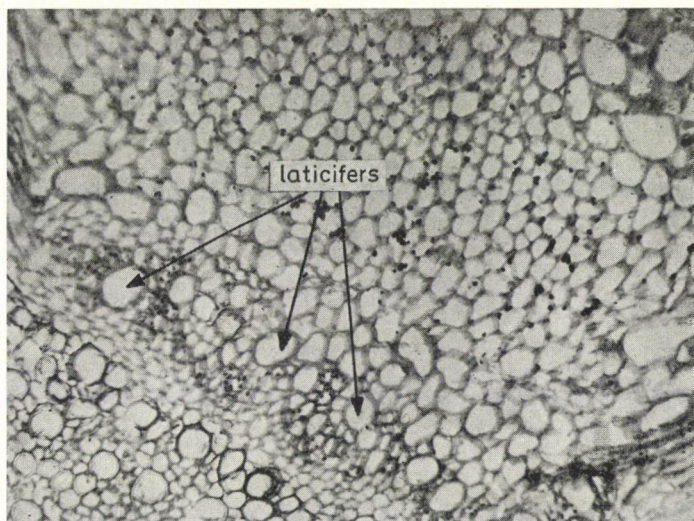


Fig. 5. Cross-section of the placental main bundle of the capsule wall. (After the removal of pectine and hemicellulose compounds, PAS staining, 252 \times)

Table 1

*Absorption values (A) on the walls of laticifers
in Papaver somniferum L.*

Treatments	Absorption values (A)
Control	0.77
After the removal of pectine	0.71
After the removal of pectine and hemicellulose	0.55
LSD _{5%}	0.07

Table 2

*Absorption values (A) on the walls of laticifers
in Papaver somniferum L. measured at the anastomosis*

Treatments	Absorption values (A)
Control	0.77
After the removal of pectine	0.74
After the removal of pectine and hemicellulose	0.65
LSD _{5%}	0.06

hybrids of *Papaver somniferum*. The F-test does not reveal a significant difference even at a probability level of $P = 10\%$ (the calculated value of F 1.71 is lower than the value in the tables: 2.81). Subsequently, in evaluating the statistical data obtained in the course of the investigations all the data were jointly taken into consideration (Tables 1, 2).

It has been established that the cell walls of laticifers contain 29% hemicellulose and 71% α -cellulose on average; though on the basis of fewer data, it was also concluded that the percentage composition of the cell wall in the anastomosis differs from that at other places in the cell wall: there was 16% soluble hemicellulose and 84% α -cellulose.

The investigations confirm the observation made by NESSLER—MAHLBERG (1976, 1977a, b), that in the anastomosis the cell wall differs from that in other parts of the laticifer and it seems probable that the situation is the same with *Cichorium intybus*.

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*

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DATA ON THE REDUCTION IN IMPROVING EFFECT OF A. I. BULLS IN RELATION TO THE GENETIC TREND OF THE POPULATION

In order to clarify the question of the reduction in improving effect of A. I. bulls in relation to the genetic trend of the population the authors carried out two model calculations.

a) This assumed different genetic progress as well as different improving effects of bulls. The duration and extent of improving effect were examined.

b) The data on a US-Holstein-Friesian elite population were processed to determine changes in improving effect over an interval of 10 years, assuming 1% genetic gain per year. 10% of this elite population were chosen and examined as a "nucleus population".

The results are presented in figures and tables. The conclusions are as follows: 1. In female populations representing continuous, considerable genetic progress, even bulls with excellent genetic merit can only assure improvement for a few years. 2. The improving effect may only be referred to a definite population if the progeny test results are directly related to the average of the population, or if these can be adjusted properly. 3. A "nucleus population" selected and maintained by high selection pressure could have such great genetic superiority that progress is assured for a long time in a "population with high breeding value". 4. A significant genetic advance has to be achieved, maintained and utilized in the sire-

producing mating category. This requires a reasonable rationalization of selection and mating, the utilization of international gene resources, and continuous control of the breeding value of the sires in the populations.

The improving effect of A. I. sires shows a continuous decrease. The term of the improving effect depends on both the extent of the improving effect and the extent of genetic progress in the female population. The improving effect of a given bull stud is therefore relative in time and space. ROBERTSON (1979) calls attention to the fact that in general the genetic progress achieved amounts to only about half the theoretically expected genetic gain. This might be explained first of all by the fact that the number of progeny-tested bulls is not optimal in relation to that of A. I. bulls, and by insufficiencies in the selection of the bull-dams and of the sires of young bulls. Another reason is that the average age (generation interval) of the mothers of young sires and of the sires of young bulls is higher than that taken into account by theoretical estimations.

According to VAN VLECK (1977), the relatively small extent of genetic progress achieved may be attributed to the fact that traits not directly connected with the production (breeding aim) are greatly overestimated in selection. In estimating the breeding value of bulls, the evaluation of later production records of cow-progenies is given exaggerated importance, thus considerably increasing the generation interval.

AKAHORI—MITSUMOTO (1977) report that the more sires which are replaced by young bulls, the greater could be the genetic progress. About 80% of the genetic improvement in the population may be attributed to selection among the young sires.

It is clear that the assertion of modern population genetic principles is essential in breeding programmes. By using pure breeding, genetic progress of 1—2% per year may be optimally expected for milk production (LINDSTRÖM 1969, SKJERVOLD 1974, ROBERTSON 1979). A decisive role is played by the mating category of the mothers of young sires and the sires of young bulls, amounting to 70—75% of the genetic progress (FRANZ 1974, after DOHY 1979).

With the development of international integration in breeding, and because of the continuous genetic gain in milk production, the repeated supervision of the estimated breeding value of sires represents a permanent task. From this point of view it is important to compare the breeding values with the breed average. It is worth noting that in the US-Holstein-Friesian breed it has been found (DAVIS 1976, after DOHY 1979) that when the results of the progeny test surpasses a repeatability of 70% and a milk surplus of +300 kg, the breeding value of the bull exceeds the average of the breed at the 99% level of probability. This statement should also be reviewed periodically with respect to the genetic trend in the population. AVERDUNK (1975) suggests a simple method of correcting the results to make it possible to compare the breeding values estimated in various years. In his opinion, the simplest way is to subtract the value of the genetic trend from the current estimate of breeding value.

Based on conclusions found in the literature, and on the normal practice in modern breeding schemes, two model calculations were carried out to clarify the question discussed above.

a) In the first model calculation it was assumed that the improving effect of sires (milk kg/year) amounts to 1, 2, 3, 4, 5 and 10%, and the genetic trend in the female population amounts to 0.5, 1.0, 1.5 and 2% of the milk quantity per year. The duration and extent of the improving effect of bulls having different genetic merit was demonstrated for populations representing different degrees of genetic progress. The calculations were based on a population with 4000 kg FCM.*

* Fat Corrected Milk

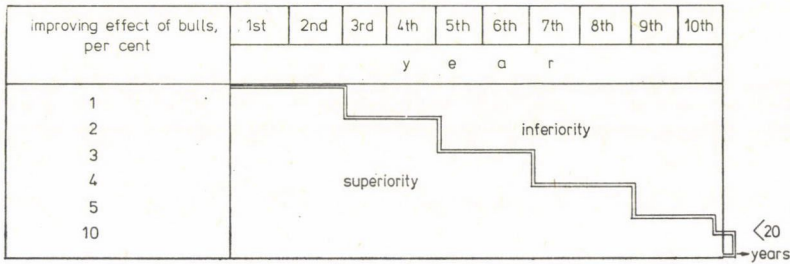


Fig. 1/a. Changes in improving effect of bulls with different breeding values depending on the genetic progress in the population. Genetic progress in the female population: 0.5% per year

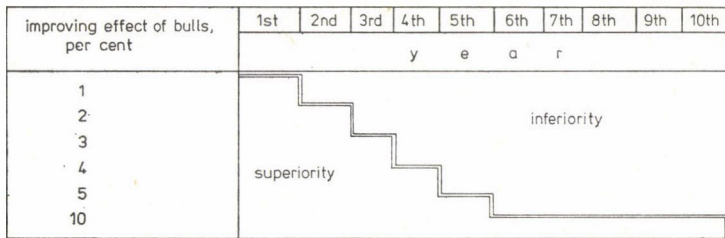


Fig. 1/b. Changes in improving effect of bulls with different breeding values depending on the genetic progress in the population. Genetic progress in the female population: 1.0% per year

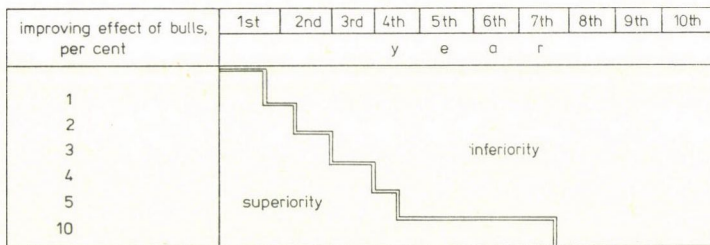


Fig. 1/c. Changes in improving effect of bulls with different breeding values depending on the genetic progress in the population. Genetic progress in the female population: 1.5% per year

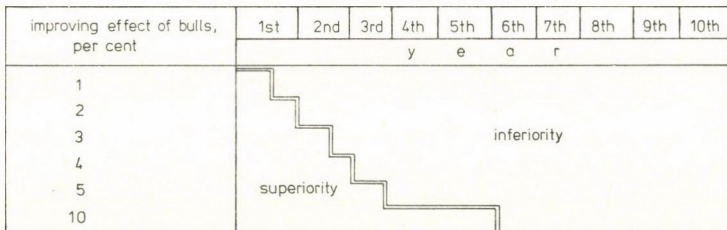


Fig. 1/d. Changes in improving effect of bulls with different breeding values depending on the genetic progress in the population. Genetic progress in the female population: 2% per year

Table 1

Improving effect (milk kg) of bulls with high breeding value in "elite"

Population	Initially	After		
		1	2	3
		years		
<i>Population with high breeding value*</i>				
— Average milk production of cows, kg	7300	7373	7447	7521
— Improving effect of bulls, milk kg	+500	+427	+353	+279
<i>Nucleus population**</i>				
— Average milk production of cows, kg	8200	8282	8364	8448
— Improving effect of bulls, milk kg	+700	+618	+536	+452

* Data of 44 bulls with the highest breeding value from the total 887 Holstein-Friesian bulls reported in the "New USDA-DHIA Active A.I. Sire Summary List of Sept. 1976"

** The 4 best bulls (10%) from the 44 bulls mentioned above

Table 2

Improving effect of bulls with high breeding value as a percentage in "elite"

Population	Initially	After		
		1	2	3
		years		
<i>Population with high breeding value*</i>				
— Average milk production of cows as a percentage of milk kg	100.0	101.0	102.0	103.0
— Improving effect of bulls as a percentage of milk kg	+ 6.8	+5.8	+4.8	+3.8
<i>Nucleus population**</i>				
— Average milk production of cows as a percentage of milk kg	100.0	101.0	102.0	103.0
— Improving effect of bulls as a percentage of milk kg	+ 8.5	+7.5	+6.5	+5.5

* Data of 44 bulls with the highest breeding value from the total 887 Holstein-Friesian bulls reported in the "New USDA-DHIA Active A.I. Sire Summary List of Sept. 1976"

** The 4 best bulls (10%) from the 44 bulls mentioned above

b) In the second model calculation the data of an actual population were processed: 44 bulls of the highest breeding value selected from 887 Holstein-Friesian bulls published in the "New USDA-DHIA Active A. I. Sire Summary List of Sept. 1976". The progeny records of the 44 sires selected represented a "population with high breeding value". Furthermore, the 4 best sires from this stud were chosen as a "nucleus population".

USA-Holstein-Friesian" populations in the case of 1% genetic progress per year

After						
4	5	6	7	8	9	10
years						
7596	7672	7749	7826	7904	7983	8063
+204	+128	+51	-26	-104	-183	-263
8533	8618	8704	8791	8879	8968	9058
+367	+282	+196	+109	+21	-68	-158

USA-Holstein-Friesian" populations in the case of 1% genetic progress per year

After						
4	5	6	7	8	9	10
years						
104.0	105.1	106.1	107.2	108.3	109.4	110.4
+2.8	+1.7	+0.7	-0.4	-1.4	-2.5	-3.6
104.1	105.1	106.1	107.2	108.3	109.4	110.5
+4.5	+3.4	+2.4	+1.3	+0.3	-0.8	-1.9

The average production of the progeny groups of the bulls and of their contemporaries served as the basis for the calculations. Assuming a genetic progress of 1% per year in the female population it was demonstrated to what extent:

— the improving effect of the sires will change over 10 years in the "population with high breeding value";

— the breeding value of the sires used in the “nucleus population” will change over 10 years, and

— the genetic superiority of the “nucleus population” manifests itself compared with the “population with high breeding value”.

c) The progeny test results for the champion sire Seiling Rockman in 1964, 1974 and 1979 were compared.

The results of the calculations are summarized in Figs 1/a—d and in Tables 1 and 2 (the double line marks the border between the superiority and inferiority of bulls for the appropriate genetic progress of the female population). It may be stated that, even using sires with an improving effect of at least +3%, the average abilities of the population can only be increased for a few years.

It should be noted that the improving effect can only be referred to a definite population if the results of the progeny test are directly related to the average of the population or if these can be properly adjusted.

In the case of a genetic gain of 1% per year the increase in milk production over a 10 year interval may be practically linear. Within this period the cumulative effect of the genetic trend scarcely asserts itself.

In the “population with high breeding value”, in which the average improving effect amounted to +500 kg milk, the superiority of the sires after 5 years diminished to zero.

A “nucleus population” selected and maintained by high selection pressure could have such great genetic superiority (Table 1) that progress is assured in the “population with high breeding value” for a long time (10—20 years).

Owing to the positive genetic trend that asserts itself in the population, the improving effect of Seiling Rockman, which prevailed 19 years ago, has now been eliminated. As far as milk quantity is concerned, the improving effect in 1964, 1974 and 1979 respectively, was +22% (BCA* in Canada), and +9 kg and —23 kg in the USA.

It is of key importance to establish the improvement and differentiation of the “nucleus population” according to breeding aims (HINKS 1978) because:

- the international integration of breeding is being emphasized more and more widely;
- up-to-date techniques (including biotechniques), the concentration of selection bases, and the modern organization of breeding will accelerate genetic progress.

Taking all these statements into consideration, a significant genetic advance has to be achieved, maintained and utilized in the sire-producing mating category. This requires a reasonable rationalization of selection and mating, the utilization of international gene resources, and continuous control of the breeding value of the sires in the populations.

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* Breed-Class-Average

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VARIA II

INHERITANCE OF MARKER GENES FOR LEAF COLOUR AND SHAPE IN WATERMELON, CITRULLUS LANATUS, THUMB.

Commercial F_1 hybrids of watermelon have been available in the seed trade for several years, but have not been extensively grown. The reason is probably a cost-merit relationship. The quality and productivity of a given hybrid must be great to justify the high price paid for the original seeds and also for the product. The high cost of hybrid watermelon primarily stems from the technical labour involved in hand pollination and the selective harvesting of crossed fruits. MOHR *et al.* (1955) suggested the use of an incompletely dominant seedling marker, e.g. non-lobed leaf, in the seed parent as a possible means of eliminating hand work in the production of hybrids. However, the highest incidence of crossing reported was 36%. The roguing of undesirable plants has to be carried out by the grower. Other traits such as short internode can be a useful genetic marker, as suggested by MOHR (1963) and ALLAN (1976).

The genetic behaviour of leaf colour and ovary shape was reported by FILOV (1939), BARHAM (1956), WARID *et al.* (1971) and ALLAN (1976).

This paper deals with a possible marker character, yellow foliage, found in a variety introduced from Japan in 1957. After several generations of selfing, the plants became homozygous and bred true for this colour. The strain was named Yellow Skin. The yellow colour spreads over the leaves, stem and fruits. The yellowish colour of the leaf becomes prominent at the second or third true leaf stage. This colour starts from the petiole to the mid-rib and veinlets of the leaf until it reaches the tip of the terminal lobe of the leaf. The colour of the ovary and that of the developing fruit is yellow. The fruit is round with red flesh and dark brown seeds. Ovary shape was also studied in this investigation to evaluate its merits as a marker trait in the same plant material.

Congo and Yellow Skin cultivars were the parents used in crossing. Both cultivars were monoecious. The Congo parent possessed green foliage and elongated ovaries, whereas Yellow Skin had yellow foliage and spherical ovaries. Selfing of the parents continued for ten or more generations before hybridization began. The cross was made in 1972. Selfing of the hybrid material and backcrossing continued up to 1975. The seeds of P_1 , P_2 , F_1 , F_2 , BC and F_3 were planted on March 30th 1976 at the Vegetable Experimental Station of the Faculty of Agriculture, Cairo University, at Giza. One cross was made between Congo and Yellow Skin. Congo was the female parent. Two qualitative characters, namely, colour of foliage and shape of ovary, were studied.

The plants in different generations were classified at the time of anthesis of female flowers. With respect to the colour of foliage, three grades: yellow, pale yellow and green, were recorded. For ovary shape three categories: elongated, semi-elongated and spherical, were visually classed. To reveal the mode of inheritance of each character, the chi-square test was applied for the analysis of the data.

Colour of Foliage. The data presented in Table 1 indicate that the female parent Congo possessed green foliage and the male parent Yellow Skin exhibited yellow foliage. All F_1 plants were pale yellow. The terminal lobes of the leaves and the midribs were conspicuously yellow. This colour grade was not intermediate between the colour grades of the parents. The partial dominance of the yellow colour was evident.

Five F_2 populations were studied. The segregation in most populations was a good fit to the ratio 1 yellow: 2 pale yellow: 1 green. The χ^2 and P values ranged from 0.7818 to 8.4761 for the former and 0.01—0.75 for the latter. The five F_2 populations were homogeneous

Table 1

Expression of leaf colour in parents, F_1 , F_2 , F_3 and backcross populations in the cross:
Congo 17-3 \times Yellow Skin 20-15

Pedigree	Generation	No. of plants observed			Ratio	χ^2	P
		yellow	pale yellow	green			
17-3	P_1	0	0	6			
20-15	P_2	11	0	0			
17-3 \times 20-15	F_1	0	48	0			
F_1 -238 self.	F_2	7	29	11	1 : 2 : 1	3.2553	0.10—0.25
F_1 -247 self.	F_2	5	6	3	1 : 2 : 1	0.8572	0.50—0.75
F_1 -249 self.	F_2	17	12	13	1 : 2 : 1	8.4761	0.01—0.025
F_1 -256 self.	F_2	11	30	14	1 : 2 : 1	0.7818	0.50—0.75
F_1 -257 self.	F_2	6	19	8	1 : 2 : 1	1.0000	0.50—0.75
Total χ^2						14.3704	0.10—0.25
Pooled χ^2		46	96	49	1 : 2 : 1	0.0994	0.95—0.975
Heterogeneity χ^2						14.2710	0.05—0.10
F_2 -248 self.	F_3	85	0	0			
F_2 -254 self.	F_3	20	0	0			
F_2 -239 self.	F_3	2	7	6	1 : 2 : 1	2.2000	0.25—0.50
F_2 -244 self.	F_3	18	33	15	1 : 2 : 1	0.2728	0.75—0.90
F_2 -245 self.	F_3	16	16	13	1 : 2 : 1	4.1556	0.10—0.25
F_2 -246 self.	F_3	15	19	14	1 : 2 : 1	2.1250	0.25—0.50
F_2 -252 self.	F_3	18	27	15	1 : 2 : 1	0.9000	0.50—0.75
F_2 -253 self.	F_3	4	14	13	1 : 2 : 1	5.5162	0.05—0.10
F_2 -240 self.	F_3	0	0	29			
F_2 -241 self.	F_3	0	0	38			
F_2 -242 self.	F_3	0	0	88			
F_2 -250 self.	F_3	0	0	85			
$F_1 \times$ 20-5	BC- P_2	14	14	0	1 : 1	0.0000	

since the heterogeneity χ^2 value was 14.2710 with a P value of 0.05—0.10 on the basis of 1 yellow : 2 pale yellow : 1 green. It was concluded that foliage colour was controlled by a single pair of genes.

Twelve F_3 families were obtained through selfing 12 F_2 plants selected at random within the three phenotypic classes: yellow, pale yellow and green. The yellow F_2 plants, two in number, gave rise to progenies the plants of which were all yellow in colour. This would indicate the homozygosity of the selfed F_2 plants. The pale yellow F_2 plants, six in number, gave segregating F_3 progenies where segregation was a relatively good fit to 1 yellow : 2 pale yellow : 1 green. This would indicate that the selfed F_2 plants were heterozygous in one pair of genes. The four F_2 plants with green colour bred true for the green colour since their progenies were green.

On backcrossing F_1 plants to the parent with yellow foliage, namely Yellow Skin, the resultant progeny segregated according to the ratio 1 yellow : 1 pale yellow, indicating that

the colour of the foliage is controlled by one pair of genes. It is concluded from data on F_1 , F_2 , F_3 and BC populations that this character is monogenically inherited, with partial dominance of the yellow over the green colour. The gene symbol $Y-y$ is suggested. The genotype of the yellow parent (Yellow Skin) is YY , and that of the green parent (Congo) yy . All F_1 plants recorded in this study were pale yellow, suggesting the homozygosity of the two parents. The following factorial analyses are suggested:

P_1	yy	green
P_2	YY	yellow
F_1	Yy	pale yellow
F_2	YY	1 yellow
	Yy	2 pale yellow
	yy	1 green
	YY	1 yellow
$BC-P_2$	Yy	1 pale yellow

F_3 will or will not segregate for foliage colour according to the genotype of the selfed F_2 plant as follows:

F_2		F_3 Phenotype
Genotype	Phenotype	
YY	yellow	yellow
Yy	pale yellow	1 yellow : 2 pale yellow : 1 green
yy	green	green

The phenotype is a direct manifestation of the genotype. Obviously, this character can be utilized as a genetic marker. The foliage of an F_1 plant, obtained by crossing yellow and green parents, would show the pale yellow colour.

This conclusion is not in agreement with that of FILOV (1939) who found that green colour was dominant over yellow. It also deviates from the conclusion of BARHAM (1956) who experimented with chlorotic foliage, which starts when the first fruits are at the ripening stage, and was under the control of a single recessive gene. The disagreement might be attributed to the fact that a different watermelon germplasm was used in each case. The dominant status of the yellow colour in watermelon foliage, genetically revealed at the diploid level in the present study, is in accordance with the results reported by WARID *et al.* (1971) when diploid, triploid and tetraploid material was involved.

Ovary Shape. The female flowers of the Yellow Skin cultivar possess spherical ovaries, whereas those of Congo have elongated ovaries. The results shown in Table 2 indicate that the F_1 possessed semi-elongated ovaries. The partial dominance of the elongated shape was thus evident. Five F_2 plants were grown and proved to be homogeneous with respect to a segregating rate of 1 elongated : 2 semi-elongated : 1 spherical. The heterogeneity χ^2 value was 2.7770 and the P value was 0.90–0.95 on the basis of a 1 : 2 : 1 ratio. The segregation in most F_2 populations was a good fit to the ratio 1 elongated : 2 semi-elongated : 1 spherical. The P values ranged from 0.10 to 0.975. This would indicate that the two parents differed in one pair of genes controlling ovary shape.

Twelve F_2 plants were selfed: four with elongated ovaries, four with spherical ovaries and four with semi-elongated ovaries. The first eight F_3 populations did not segregate for ovary shape, but each had apparently descended from a homozygous F_2 plant and produced progeny characterized by either elongated or spherical ovaries. The other F_3 populations segregated nearly according to the ratio 1 elongated : 2 semi-elongated : 1 spherical. The χ^2 and P values were 0.3882–6.4319 and 0.10–0.90, respectively. These populations would have their F_2 parentage heterozygous in one factor pair for ovary shape.

The backcross of F_1 to the spherical parent segregated into semi-elongated and spherical ovaries. A χ^2 value of 1.2858 and a P value of 0.25–0.50 indicate that segregation was a good fit to the 1 : 1 ratio. The monogenic inheritance of ovary shape was thus confirmed, with the spherical shape being recessive. All the data on ovary shape indicate that the two parental cultivars Congo and Yellow Skin were homozygous with respect to this trait, which was

Table 2

*Expression of ovary shape in parents, F₁, F₂, F₃ and backcross populations in the cross:
Congo 17-3 × Yellow Skin 20-15*

Pedigree	Generation	No. of plants observed			Ratio	χ^2	P
		elongated	semi-elongated	spherical			
17-3	P ₁	6	0	0			
20-15	P ₂	0	0	11			
17-3 × 20-15	F ₁	0	48	0			
F ₁ -238 self.	F ₂	10	23	14	1 : 2 : 1	0.7021	0.50 —0.75
F ₁ -247 self.	F ₂	3	7	4	1 : 2 : 1	0.1428	0.90 —0.95
F ₁ -249 self.	F ₂	10	19	13	1 : 2 : 1	0.8095	0.50 —0.75
F ₁ -256 self.	F ₂	14	28	13	1 : 2 : 1	0.0545	0.95 —0.975
F ₁ -257 self.	F ₂	9	12	12	1 : 2 : 1	3.0000	0.10 —0.25
Total χ^2						4.7089	0.90 —0.95
Pooled χ^2		46	89	56	1 : 2 : 1	1.9317	0.25 —0.50
Heterogeneity χ^2						2.7770	0.90 —0.95
F ₂ -239 self.	F ₃	15	0	0			
F ₂ -250 self.	F ₃	65	0	0			
F ₂ -253 self.	F ₃	31	0	0			
F ₂ -254 self.	F ₃	20	0	0			
F ₂ -240 self.	F ₃	0	0	29			
F ₂ -244 self.	F ₃	0	0	66			
F ₂ -246 self.	F ₃	0	0	48			
F ₂ -252 self.	F ₃	0	0	60			
F ₂ -241 self.	F ₃	5	20	13	1 : 2 : 1	3.4737	0.10 —0.25
F ₂ -242 self.	F ₃	23	53	12	1 : 2 : 1	6.4319	0.025—0.05
F ₂ -245 self.	F ₃	15	19	11	1 : 2 : 1	1.8000	0.25 —0.50
F ₂ -248 self.	F ₃	23	43	19	1 : 2 : 1	0.3882	0.75 —0.90
F ₁ × 20-15	BC-P ₂	0	17	11	1 : 1	1.2858	0.25 —0.50

expressed by the action of one pair of genes with partial or incomplete dominance of the elongated shape. This pair of genes was tentatively designated E—e. The possible genotypes of the parents, F₁, and the segregating generations appear as follows:

P ₁	EE	elongated
P ₂	ee	spherical
F ₁	Ee	semi-elongated
F ₂	EE	1 elongated
	Ee	2 semi-elongated
	ee	1 spherical
BC-P ₂	Ee	1 semi-elongated
	ee	1 spherical

F_3 would segregate for ovary shape or show no segregation according to the genotype of the selfed F_2 plant.

F_2		F_3 Phenotype
Genotype	Phenotype	
EE	elongated	elongated
Ee	semi-elongated	1 elongated : 2 semi-elongated : 1 spherical
ee	spherical	spherical

The easy identification of ovary shape at the time of the appearance of female flowers, and the simple mode of inheritance of this characteristic would render it a valuable genetic marker.

The present data are in agreement with that reported by ALLAN (1976) who found the semi-elongated ovary to be dominant over spherical and elongated ones in one pair of genes.

Association between leaf colour and ovary shape. The genetic linkage was calculated in F_2 and backcross populations and the data are shown in Table 3. The original cross, in the repulsion phase, was between the Congo cultivar, with green foliage and elongated ovary, and the Yellow Skin cultivar, with yellow foliage and spherical ovary. The parental genotypes can be expressed as yyEE for Congo and YYee for Yellow Skin. All the F_1 plants possessed pale yellow foliage and semi-elongated ovaries. Each of the two characteristics was dependent on one pair of genes showing partial dominance.

The segregation in F_2 populations for both leaf colour and ovary shape was a good fit to the expected ratio of 1 yellow leaf, elongated ovary : 2 yellow leaf, semi-elongated ovary : 1 yellow leaf, spherical ovary : 2 pale yellow leaf, elongated ovary : 4 pale yellow leaf, semi-

Table 3

Segregation in F_2 and backcross generations with respect to both leaf colour and ovary shape and their expression in parents and F_1 in the cross: Congo (P_1) \times Yellow Skin (P_2)

Phenotype	Generation				
	P_1	P_2	F_1	F_2^*	BC- P_2^{**}
Yellow leaf, elongated ovary	—	—	—	9	—
Yellow leaf, semi-elongated ovary	—	—	—	21	8
Yellow leaf, spherical ovary	—	11	—	16	6
Pale yellow leaf, elongated ovary	—	—	—	22	—
Pale yellow leaf, semi-elongated ovary	—	—	48	50	9
Pale yellow leaf, spherical ovary	—	—	—	24	5
Green leaf, elongated ovary	6	—	—	15	—
Green leaf, semi-elongated ovary	—	—	—	18	—
Green leaf, spherical ovary	—	—	—	16	—
N	6	11	48	191	28

* Ratio in F_2 1 : 2 : 1 : 2 : 4 : 2 : 1 : 2 : 1
 X^2 6.3194
P 0.50—0.75

** Ratio in BC- P_2 1 : 1 : 1 : 1
 X^2 1.4286
P 0.50—0.75

elongated ovary : 2 pale yellow leaf, spherical ovary : 1 green leaf, elongated ovary : 2 green leaf, semi-elongated ovary : 1 green leaf, spherical ovary. The computed values of χ^2 and P were 6.3194 and 0.50—0.75, respectively. Evidently, leaf colour and ovary shape were independently inherited, and no linkage could be detected between the genes involved. Thus genes Y—y and E—e are located on separate chromosomes. This conclusion was also reached from an analysis of the backcross results. The backcross of F_1 to the Yellow Skin parent can be factorially expressed as: $YyEe \times YYee$. The progeny is expected to segregate into yellow, semi-elongated : yellow, spherical : pale yellow, semi-elongated : pale yellow, spherical ovaries in a ratio of 1 : 1 : 1 : 1, where an independent assortment of genes is manifested. The data indicate that the observed and expected segregating ratios were a good fit since the χ^2 and P values were 1.4286 and 0.50—0.75, respectively.

It was generally observed that plants with yellow foliage produced fruits with a yellow rind. Consequently a strain of watermelon characterized by elongated ovaries and fruits was produced. The colour is yellow for the foliage and fruits. It is designated Yellow Elongated.

No mention of this association has been found in the available literature on watermelon.

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A STUDY OF GROWTH PATTERN IN JUTE (*CORCHORUS OLITORIUS* L.)

In any jute breeding work undertaken for improvement of fibre yield, selection of plants is made on the basis of their size or, to be more precise, on the basis of two characters, their height and basal diameter, which are known to be highly positively correlated with fibre yield (KUNDU *et al.* 1959). Further, a variety which attains a large plant size within a reasonably short time is likely to be preferred, not only because a good yield of fibre can be obtained from the variety, but also because the field it occupies can be released earlier than in the case of others, enabling certain suitable crops to follow. There appears to be another advantage of harvesting jute crops early: a preliminary study has indicated that, on the whole, the fibre tenacity of jute varieties decreases with an increase in crop age (MAITI *et al.* 1975, 1977).

For the reasons stated above, it would be natural for a plant breeder to look for varieties which possess a fast rate of growth, particularly in the early stages of development. However, not much is yet known regarding the existence of variation among the available genotypes in respect of this character. This applies even more in respect of the nature and extent of the

variation. This information is necessary for judging the suitability of genotypes either for direct cultivation or for use in breeding programmes. In view of this, the present investigation was undertaken to study the rate of growth of 21 genotypes of *C. olitorius* with respect to plant height, basal diameter and yield of fibre at various intermediate time points during their growth period.

Twenty one genotypes of *C. olitorius* obtained from the germplasm collection of the Jute Agricultural Research Institute, Indian Council of Agricultural Research, were used in this experiment. The genotypes are:

1. Chinsurah Green; 2. JRO—632; 3. JRO—753; 4. Sudan Green; 5. Bangkok—I; 6. JRO—620; 7. Least pigmented; 8. Crumpled leaf; 9. Olitorius red—I; 10. Olitorius red—II; 11. R—26; 12. O—50—4963; 13. O—59—471; 14. Salyout; 15. Wild olitorius red; 16. Black grey seed; 17. JRO—878; 18. JRO—4362; 19. JRO—7835; 20. Tanganika—I; 21. Tanganika—II.

The experiment was sown on 2nd May 1973, at the Government Seed Farm, Chinsurah in randomized blocks with six replications, each plot in a block consisting of a row of 15 plants all belonging to one genotype. The soil of the experimental site was clayey loam. All the recommended agronomic practices for *olitorius* jute, including the fertilizer dose ($N_{40}P_{20}K_{40}$ kg/ha), were adopted uniformly in the case of all the genotypes. The climatic conditions prevailing at the experimental site during the crop season were as follows:

Month	Temperature (°C)		Relative humidity (%)		Rainfall (mm)
	max.	min.	morning	afternoon	
May	34.7	24.9	87	60	160.5
June	32.8	25.9	88	73	375.5
July	31.1	25.8	91	77	240.7
August	30.8	25.5	92	77	330.1
September	30.6	26.0	91	79	230.0

For observation, six blocks were divided into two sets: the first set consisted of one block (randomly selected) and the second set consisted of the remaining five blocks. In the first set, 5 plants were selected at random from each row of the block. These plants were marked and kept fixed and observations on plant height (PH) and basal diameter (BD) were recorded on them at 10 day intervals starting from a crop age of 80 days and continuing up to 130 days. These measurements will be referred to as the first set of data. The remaining five blocks (second set) were harvested one after another, at 10 day intervals starting from a crop age of 90 days, i.e. one block was harvested at 90 days, another at 100 days, and so on. At the time of harvest, 10 plants were selected at random from a row and two bundles of 5 plants each were made from them and steeped in water for retting. After extraction, the dry fibre weight of each bundle was recorded. Further, in the second set, 10 genotypes out of 21 were selected at random and the PH and BD of each of the 10 plants in them were measured in all the five harvests.

Two different series of data were, therefore, obtained, the first consisting of the PH and BD values for each selected plant of a genotype at six different equispaced points in time, giving the growth increments of the characters, and the other consisting of fibre yields for two bundles of 5 plants each, at five different ages of the crop for each genotype. In addition, in the case of 10 genotypes of the second set, the PH and BD values of the plants in each bundle were also obtained.

The fibre yield data at different crop ages of the genotypes did not show clear trends, presumably because the data were necessarily based on different sets of 10 plants — a small number which did not average out other variations so as to manifest the effect of age. Thus, the results could not be satisfactorily summarized by mean values. Therefore, a regression of fibre yield (Y) on PH, BD and age (X) was first calculated from the second set of data. The PH and BD values of the fixed set of plants, recorded at 10 day intervals in the first set, were then fed into this regression for estimating the fibre yield of the genotypes at different crop ages.

The growth increments for 10 day periods, starting from 80 days, were calculated for PH, BD and estimated fibre yield for all the 21 genotypes. For each of these characters a

Table 1

The constants a , b and c of the second degree curve $y = a + bx + cx^2$ fitted to the 10-day increments (per plant) for plant height, basal diameter and fibre yield. $x = (\text{age} - 70 \text{ days})/10$

Genotype	Plant height			Basal diameter			Fibre yield		
	a	b	c	a	b	c	a	b	c
1.	15.4	11.08	-2.71	0.0792	0.0436	-0.0111	1.778	0.161	-0.0414
2.	15.4	12.65	-3.14	0.0852	0.0209	-0.0055	1.553	0.156	-0.0500
3.	3.0	18.81	-3.78	-0.1428	0.1718	-0.0285	1.004	0.684	-0.1242
4.	24.4	3.86	-1.71	0.0228	0.0318	-0.0070	1.726	0.121	-0.0407
5.	5.2	17.68	-3.71	-0.0284	0.0782	-0.0141	1.262	0.446	-0.0864
6.	21.2	5.34	-1.85	0.0252	0.0415	-0.0084	1.656	0.182	-0.0478
7.	7.6	12.08	-2.71	-0.0032	0.0271	-0.0048	1.415	0.236	-0.0500
8.	22.6	1.05	-1.14	0.0564	0.0099	-0.0032	1.772	0.026	-0.0221
9.	16.6	5.61	-1.78	0.0216	0.0552	-0.0111	1.586	0.211	-0.0514
10.	18.0	5.88	-2.28	0.0808	0.0045	-0.0038	1.132	0.175	-0.0528
11.	19.4	5.47	-1.92	0.0288	0.0383	-0.0084	1.664	0.145	-0.0428
12.	7.0	16.22	-3.57	-0.0844	0.1198	-0.0197	1.184	0.528	-0.1000
13.	1.2	19.01	-3.78	-0.0832	0.1193	-0.0202	1.112	0.576	-0.1064
14.	7.0	12.41	-2.78	-0.0876	0.1211	-0.0188	1.226	0.437	-0.0807
15.	16.6	7.98	-2.21	0.0728	0.0324	-0.0080	1.734	0.366	-0.0900
16.	13.6	6.15	-1.64	0.0136	0.0438	-0.0097	1.106	0.155	-0.0407
17.	16.4	9.04	-2.35	0.2152	-0.1059	0.0149	1.118	0.134	-0.0114
18.	-0.4	19.08	-3.71	0.2956	-0.1297	0.0147	1.964	-0.010	-0.0221
19.	6.2	15.64	-3.35	0.2864	-0.1413	0.0174	2.056	-0.021	-0.0307
20.	1.4	20.05	-4.14	0.0380	0.0640	-0.0207	1.086	-0.086	-0.0221
21.	5.0	16.50	-3.50	0.0768	0.0277	-0.0083	1.556	0.299	-0.0692

second degree curve was fitted to the increments, from which the smoothed growth increments during the different 10 day periods, the age interval when the increment was greatest and the time point when growth rate appeared to be maximum, were determined. In the case of fibre yield, a logistic curve was also fitted to the yields at different ages and from this the fibre yield obtainable at different ages and the age point for maximum growth rate were determined. This was done to see the agreement between the two methods.

The regression of yield (Y) on PH, BD and age (X), determined from the second set of data, is $Y = -3.3312 + 0.0145 \text{ PH} + 2.2731 \text{ BD} + 1.2986 X$. The constants a , b and c of the second degree curve $Y = a + bx + cx^2$ fitted to the 10 day increments (per plant) for PH, BD and fibre yield are shown in Table 1, where the origin for time (X) is at 70 days and a unit of 10 days has been used. The negative values of the constant c in these curves for each of the three characters studied indicate that the growth increment took place first at an increasing rate, and then at a decreasing one. However, some discrepancy was observed in genotypes 17, 18 and 19 in respect of BD, where the c values obtained were, unlike the others, positive. This was perhaps due to certain factors pertaining to environment rather than being characteristic of the types themselves.

Growth increments in respect of PH, BD and fibre yield for successive 10 day periods, starting from a crop age of 80 days, were calculated from the second degree curves and are presented in Tables 2, 3 and 4. Further, the maximum increment in a 10 day period in respect

of each of the three characters, and the age interval for attaining the maximum, have also been calculated from the same curves. The growth rate was the fastest at the midpoints of these age intervals; these were determined by finding the maxima of the curves.

It is evident from Table 2 that, in the case of PH, the growth increment of all the types was negligible after 120 days, and that the age for attaining the fastest growth rate was between 90 and 100 days in as many as 16 cases. In the remaining 5, however, the fastest growth rate was attained earlier than 90 days. Of these 5, type 8 was the earliest.

A marked difference was found between the types in respect of the maximum increment in PH obtained in a 10 day period, the range being from 19.36 cm (type 16) to 28.14 cm (type 2). As many as 10 types were found to have a maximum increment of more than 25 cm, another 10 between 20 cm and 25 cm, and only one less than 20 cm.

It may be seen from Table 3 that, as compared to PH, BD grew at an increasing rate for a longer period in 13 cases at least and that except for one of the types (type 10) all the others attained the maximum growth rate between 90 and 107 days. Judging from the maximum increment values of BD, types 1, 2, 3, 14, 15 and 21 were found to have good growth. It might be mentioned here that, in the case of BD, certain odd values were obtained with

Table 2

Successive 10-day growth increments in plant height (per plant in cm) between 80—130 days of age, maximum increment obtainable in a 10-day period, the age interval of attaining the maximum increment and the age point where growth rate is fastest (from fitted second degree curves)

Genotype	10-day growth increments					Maximum increment	Age interval	Age point
	80—90	90—100	100—110	110—120	120—130			
*1.	23.77	26.72	24.25	16.36	3.05	26.72	90—100	95
**2.	24.92	28.14	25.08	15.74	0.12	28.14	90—100	95
*3.	18.03	25.50	25.41	17.76	2.55	26.40	95—105	100
**4.	26.58	25.31	20.62	12.51	0.98	26.60	81— 91	86
*5.	19.18	25.71	24.82	16.51	0.78	26.24	94—104	99
*6.	24.69	24.48	20.57	12.96	1.65	25.05	84— 94	89
*7.	16.98	20.91	19.42	12.51	0.18	21.04	92—102	97
*8.	22.52	20.14	15.48	88.54	0.68	22.85	75— 85	80
*9.	20.43	20.70	17.41	10.56	0.15	21.02	86— 96	91
**10.	21.60	20.64	15.12	5.04	—9.60	21.79	83— 93	88
*11.	22.94	22.63	18.46	10.43	1.46	23.28	84— 94	89
*12.	19.66	25.17	23.54	14.77	1.14	25.43	93—103	98
*13.	16.44	24.08	24.16	16.68	1.64	25.06	95—105	100
14.	16.64	20.68	19.16	12.08	0.56	20.82	92—102	97
*15.	22.38	23.71	20.62	13.11	1.18	23.79	88— 98	93
*16.	18.11	19.34	17.29	11.96	3.35	19.36	89— 99	94
*17.	23.09	25.08	22.37	14.96	2.85	25.09	89— 99	94
*18.	14.98	22.91	23.42	16.51	2.18	24.11	95—105	100
*19.	18.48	24.06	22.92	15.06	0.48	24.42	93—103	98
*20.	17.32	24.94	24.28	15.34	1.88	25.67	94—104	99
*21.	18.00	24.00	23.00	15.00	0.00	24.44	94—104	99

* Fit given by the second degree curve is significant at the 5% level

** Fit given by the second degree curve is significant at the 1% level

Table 3

Successive 10-day growth increments in basal diameter (per plant in cm) between 80—130 days of age, maximum increment obtainable in a 10-day period, the age interval of attaining the maximum increment and the age point where growth rate is fastest (from fitted second degree curves)

Geno-type	10-day growth increments					Maximum increment	Age interval	Age point
	80—90	90—100	100—110	110—120	120—130			
1.	0.1177	0.1220	0.1101	0.0760	0.0197	0.1220	90—100	95
2.	0.1006	0.1050	0.0984	0.0808	0.0522	0.1051	89— 99	94
3.	0.0006	0.0865	0.1154	0.0873	0.0022	0.1154	100—110	105
4.	0.0476	0.0584	0.0552	0.0380	0.0068	0.0589	93—103	98
5.	0.0358	0.0715	0.0790	0.0583	0.0094	0.0798	98—108	103
6.	0.0584	0.0746	0.0740	0.0566	0.0224	0.0764	95—105	100
7.	0.0192	0.0316	0.0344	0.0276	0.0112	0.0364	98—108	103
8.	0.0632	0.0630	0.0564	0.0434	0.0240	0.0639	85— 95	90
9.	0.0657	0.0876	0.0873	0.0648	0.0201	0.0902	95—105	100
10.	0.0816	0.0744	0.0596	0.0372	0.0072	0.0824	76— 86	81
11.	0.0572	0.0666	0.0636	0.0482	0.0204	0.0670	93—103	98
12.	0.0158	0.0765	0.0978	0.0797	0.0222	0.0978	100—110	105
13.	0.0159	0.0746	0.0929	0.0708	0.0083	0.0929	100—110	105
14.	0.0148	0.0792	0.1060	0.0952	0.0468	0.1068	102—112	107
15.	0.0972	0.1056	0.0980	0.0744	0.0348	0.1056	90—100	95
16.	0.0477	0.0488	0.0577	0.0336	0.0099	0.0630	92—102	97
17.	0.1240	0.0628	0.0312	0.0292	0.0568	—	—	—
*18.	0.1806	0.0951	0.0390	0.0123	0.0150	—	—	—
*19.	0.1624	0.0734	0.0192	0.0002	0.0152	—	—	—
*20.	0.0813	0.0832	0.0437	0.0372	—0.1595	0.0874	85— 95	90
21.	0.0964	0.0990	0.0850	0.0550	0.0084	0.1000	87— 97	92

* Fit given by the second degree curve is significant at the 5% level.

regard to the 10 day periods for attaining maximum increment in 3 types, namely 17, 18 and 19. Since the magnitude of absolute growth of the characters in question in a 10 day period is very small, it is not unlikely that there was some experimental error in these three cases.

As far as fibre yield is concerned, the age point for fastest growth rate was somewhere between 90 and 103 days in as many as 17 types. For the remaining types, namely 8, 17, 18 and 19, the age points were 81, 81, 73 and 72 respectively (Table 4).

Another interesting observation is that in all the types except No. 10, fibre yield attained the fastest growth rate at an age which was intermediate between those of PH and BD. It is further very interesting to note that in type 1, this age point is 95 days for all three characters. No conclusion could, however, be drawn for types 17, 18 and 19.

In Table 5 the constants of the logistic curve fitted to the fibre yields at different ages, the fibre yields obtained at different ages as predicted by this curve, and the age point for maximum growth rate of fibre according to this curve are shown for each type. Since fibre yield is the most important criterion, logistic curves in respect of this character are presented and such curves for PH and BD are not given.

A comparison of the age points for attaining maximum growth rate in respect of fibre yield obtained from the second degree curve of increment and the logistic curve of yield shows that except for types 8, 17, 18 and 19, there is a good degree of agreement between the two methods. This leads one to expect that for practical purposes the simpler second degree curve may be used in place of the more complicated logistic curve for arriving at dependable conclusions, although growth in a biological organism is described well by curves involving exponential functions.

Tests were also made for goodness of fit of the fitted curves. It may be seen from Table 2 that the fit given by the second degree curve in respect of PH is significant at 5% for all the types except No. 14, while for types 2, 4 and 10, the fit is highly significant (at the 1% level). This shows that the growth picture can be well approximated by a second degree curve fitted to the growth increments. It is evident from Table 4 that with regard to increments in fibre yield, the fit is significant in the case of 11 types, and highly significant in two, namely 15 and 19. However, in respect of BD, the fit was only found to be significant in 3 types, namely 18, 19 and 20. The measurement error, which is relatively large for BD, appears to be one of the reasons for a significant fit only being obtained in 3 out of 21 types. This is because in

Table 4

Successive 10-day growth increments in fibre yield (per plant in g) between 80–130 days age, maximum increment obtainable in a 10-day period, the age interval of attaining the maximum increment and the age point where growth rate is fastest (from fitted second degree curves)

Genotype	10-day growth increments					Maximum increment	Age interval	Age point
	80–90	90–100	100–110	110–120	120–130			
1.	1.900	1.930	1.890	1.750	1.540	1.930	90–100	95
*2.	2.022	2.028	1.934	1.740	1.446	2.037	86–96	91
*3.	1.564	1.874	1.936	1.750	1.316	1.943	98–108	103
*4.	1.806	1.805	1.723	1.559	1.313	1.815	85–95	90
5.	1.620	1.810	1.820	1.660	1.330	1.836	96–106	101
6.	1.790	1.820	1.770	1.620	1.370	1.829	89–99	94
7.	1.586	1.672	1.658	1.544	1.330	1.678	94–104	99
8.	1.776	1.735	1.651	1.522	1.349	1.779	76–86	81
9.	1.744	1.800	1.753	1.603	1.351	1.800	90–100	95
*10.	1.254	1.270	1.181	0.986	0.686	1.276	86–96	91
11.	1.766	1.782	1.713	1.557	1.316	1.786	87–97	92
*12.	1.612	1.840	1.870	1.696	1.324	1.881	96–106	101
*13.	1.580	1.836	1.879	1.709	1.327	1.888	97–107	102
14.	1.580	1.770	1.810	1.680	1.390	1.818	97–107	102
**15.	2.010	2.106	2.022	1.758	1.314	2.106	90–100	95
16.	1.220	1.252	1.203	1.073	0.862	1.253	89–99	94
17.	1.120	1.099	1.055	0.989	0.900	1.121	76–86	81
*18.	1.933	1.857	1.737	1.572	1.363	1.967	68–78	73
**19.	2.004	1.891	1.716	1.480	1.183	2.059	67–77	72
*20.	1.150	1.170	1.145	1.076	0.964	1.170	89–99	94
*21.	1.785	1.876	1.829	1.643	1.318	1.878	92–102	97

* Fit given by the second degree curve is significant at the 5% level

** Fit given by the second degree curve is significant at the 1% level

absolute growth, BD is of small magnitude and the relative error of measurement becomes more important. The logistic curve fitted to fibre yield at different ages has given a highly significant fit for all the types.

Considering the fact that it is not generally possible to delay harvesting beyond 120 days, as this would adversely affect the following crop, and because fibre tenacity after this crop age decreases considerably (MAITI *et al.* 1975, 1977), the fibre yield at 120 days may be regarded as the maximum practicable yield (hereafter referred to as m.p.y.). In view of this, it would be worth-while determining the optimum age for harvesting (considering 120 days crop age as the maximum practicable) for the different types, although this may mean a small amount of loss in fibre yield. This loss, however, might be compensated qualitatively since it has been proved beyond doubt that early harvests give better quality fibres (MAITI *et al.* 1975, 1977). A model suggestion in this direction is that if one can afford a loss of, say, 10% of the yield obtainable at 120 days, the crop can be harvested at an age earlier than 120 days, i.e. when the yield is 90% of m.p.y. This age may be taken as the optimum for harvesting. The growth curve for fibre can be used to determine such an optimum date of harvest. The optimum ages of harvest, as found from the logistic curve, taking 90% of the yield at 120 days as acceptable, are given in Table 6. These appear to be somewhere between 109 and

Table 5

The constants of the logistic curve $Y = K/[1 + b \exp(-at)]$ for fibre yield, fibre yield at different ages (per plant in g) and the age point where rate of fibre growth is maximum, according to the logistic curve

Geno- type	Constants			Age in days						Age point
	K	a	b	80	90	100	110	120	130	
**1.	14.20	0.5993	3.127	3.44	5.23	7.31	9.35	11.05	12.28	99
**2.	14.34	0.6199	1.861	5.01	7.16	9.32	11.12	12.41	13.23	90
**3.	14.83	0.5188	3.235	3.50	5.07	6.91	8.81	10.55	11.94	102
**4.	12.35	0.6523	2.723	3.32	5.11	7.10	8.92	10.29	11.18	95
**5.	14.22	0.5365	2.807	3.73	5.38	7.25	9.11	10.70	11.93	99
**6.	13.27	0.5991	2.616	3.67	5.44	7.42	9.26	10.72	11.73	96
**7.	14.38	0.4886	2.493	4.12	5.68	7.42	9.13	10.63	11.82	99
**8.	12.30	0.6313	2.577	3.44	5.19	7.11	8.86	10.20	11.08	95
**9.	13.48	0.5653	2.551	3.79	5.50	7.39	9.18	10.65	11.71	97
**10.	12.95	0.6418	2.689	3.51	5.36	7.42	9.30	10.73	11.68	95
**11.	14.06	0.5423	2.391	4.15	5.88	7.77	9.56	11.04	12.13	96
**12.	15.17	0.4947	2.701	4.09	5.73	7.57	9.41	11.04	12.36	100
**13.	15.23	0.4947	2.811	3.99	5.61	7.45	9.30	10.97	12.31	101
**14.	13.62	0.5539	2.885	3.50	5.12	6.97	8.80	10.36	11.53	99
**15.	13.87	0.6575	2.967	3.49	5.47	7.72	9.82	11.43	12.49	97
**16.	9.98	0.7930	2.107	3.21	5.11	6.97	8.35	9.17	9.60	89
**17.	13.21	0.6206	2.838	3.44	5.23	7.25	9.17	10.68	11.72	97
**18.	12.34	0.6831	2.473	3.55	5.48	7.57	9.36	10.63	11.41	93
**19.	13.14	0.6206	2.020	4.35	6.30	8.30	10.00	11.24	12.05	91
**20.	12.41	0.6931	2.238	3.83	5.86	7.96	9.70	10.89	11.60	92
**21.	12.52	0.6575	2.907	3.20	4.99	7.03	8.91	10.35	11.29	96

** Fit given by the logistic curve is significant at the 1% level.

Table 6

Expected yield at 120 days (m.p.y.), 90% of m.p.y. and the age of attaining 90% of m.p.y. according to the logistic curve

Geno- type	Yield at 120 days	90% of m.p.y.	Age in days
1.	11.05	9.945	113
2.	12.41	11.169	110
3.	10.55	9.495	113
4.	10.29	9.261	112
5.	10.70	9.630	113
6.	10.72	9.648	112
7.	10.63	9.567	112
8.	10.20	9.180	112
9.	10.65	9.585	112
10.	10.73	9.657	112
11.	11.04	9.936	112
12.	11.04	9.936	113
13.	10.97	9.873	113
14.	10.36	9.324	113
15.	11.43	10.287	112
16.	9.17	8.253	109
17.	10.68	9.612	112
18.	10.63	9.567	111
19.	11.24	10.116	110
20.	10.89	9.801	110
21.	10.35	9.315	112

m.p.y. = maximum practicable yield (per plant in g)

113 days for the different types included in the present study. Similarly, taking into consideration any other value for the loss of fibre yield one can afford, other dates of harvest could be determined to meet specific objectives.

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INHIBITION OF CAROTENOID BIOSYNTHESIS IN CUCURBITA PEPO L. COTYLEDONS BY FLURENOL (EMD-IT 3233)

Three compounds have been found to inhibit the production of cyclic carotenoids; in all cases lycopene accumulates. Thus lycopene accumulates in pumpkin cotyledons in the presence of cycocel [(2-chloroethyl)trimethylammonium chloride] (KNYPL 1969), and in apricot, peach, tomato and citrus fruits, carrot and sweet potato roots, and in the mycelia of *Phycomyces blakesleeanus* and *Blakeslea trispora* in the presence of CPTA [2-(P-chlorophenylthio)triethylammonium chloride] (COGGINS *et al.* 1971, YOKOYAMA *et al.* 1971 Hsu *et al.* 1972, ELAHI *et al.* 1973). Nicotine also inhibits the cyclization reaction in several microorganisms and in particular causes an accumulation of lycopene in a *Mycobacterium* species that normally produces β -carotene (BATRA 1971). In pumpkin cotyledons CPTA induced a rapid formation of lycopene with a concomitant decrease in chlorophyll (FORTINO—SPLITTSTOESSER, 1974). In the present investigations the formation of lycopene and the disappearance of chlorophyll were determined in *Cucurbita pepo* cotyledons (a tissue which does not normally produce lycopene), as influenced by Flurenol [n-butyl-9-hydroxyfluorene-(9)-carboxylate], technically known as EMD-IT 3233.

Seeds of *C. pepo* were germinated in sterilized petri dishes, using Whatman No. 1 filter paper at 28°C. Etiolated seedlings were grown for 7 days in the dark and green seedlings were grown for 6 days in the dark and 1 day under a 14 hr photoperiod before treatment. The seedlings were then removed, placed on Whatman No. 1 filter paper in petri dishes, treated with 0.5, 1.0 and 2.0 mM concentrations of flurenol and placed in a growth chamber under a 14 hr photoperiod for 7 days. After 7 days the cotyledons were removed, weighed and analysed. Chlorophyll and total carotenoids were measured in 80% acetone extracts with a spectrophotometer at 480, 510, 630, 645, 652 and 665 nm; the amounts of pigments were calculated using the equations of DUXBURY—YENTSCH (1956) and β -carotene and lycopene were analysed using the method of MCCOLLUM (1953).

When various concentrations of EMD-IT 3233 were applied to either etiolated or green plants, very little growth of the cotyledons occurred. At the highest concentration (2.0 mM) no change was noticed in the weight of the cotyledons and very extensive root degeneration occurred (Table 1). It seems that the highest concentration was phytotoxic to all seedlings.

Seedlings which were treated with various concentrations of EMD-IT 3233 contained less chlorophyll than untreated cotyledons. The total amount of chlorophyll in the seedling decreased with increasing concentrations of EMD-IT 3233 (Table 2).

Cotyledons of etiolated seedlings which were treated with EMD-IT 3233 and then placed in the light rapidly produced chlorophyll. The amount of chlorophyll in the treated cotyledons, which declined after 7 days, was not significantly different from the amount of

Table 1
Effect of EMD-IT 3233 on the fresh weight of cotyledons after 7 days

Fresh wt. of cotyledons (g)	Concentration of EMD-IT 3233 in mM*			
	water	0.5	1.0	2.0
Etiolated plant	1.7	0.9	0.6	0.3
Green plant	1.9	1.1	0.8	4

* Significant at the 1% level

Table 2

Effect of EMD-IT 3233 on the chlorophyll content of green and etiolated cotyledons

Chlorophyll mg/g fresh wt.	Concentration of EMD-IT 3233 in mM*			
	water	0.5	1.0	2.0
Etiolated plant	0.53	0.39	0.29	0.17
Green plant	0.79	0.43	0.43	0.21

* Significant at the 1% level

Table 3

The increase in lycopene content in green and etiolated cotyledons treated with EMD-IT 3233

Lycopene mg/g fresh wt.	Concentration of EMD-IT 3233 in mM*			
	water	0.5	1.0	2.0
Etiolated plant	4	146	173	216
Green plant	3	124	153	197

* Significant at the 1% level

chlorophyll found in green cotyledons treated with a similar concentration of EMD-IT 3233. Concomitant with this decline in chlorophyll concentration after EMD-IT 3233 application, there was an increase in lycopene concentration.

From Table 3 it can be concluded that etiolated and green plants did not respond in a significantly different manner, and there were no differences in lycopene concentration. However, cotyledons of etiolated seedlings which were treated with EMD-IT 3233 and kept in the dark produced little lycopene. Little lycopene was also found in cotyledons from untreated seedlings. A significant quantity of lycopene was noted in the light regime. A linear relation was found between the concentration of EMD-IT 3233 and the quantity of lycopene. An increased concentration of EMD-IT 3233 resulted in an increasing amount of lycopene.

One can consider the natural carotenoids as derivatives of lycopene, the red pigment found in tomatoes, as well as in many other plants. Lycopene is a highly saturated straight hydrocarbon chain. In recent years a considerable amount of evidence has been obtained to support the view first proposed by PORTER—LINCOLN (1950) that lycopene is the immediate acyclic precursor of the cyclic carotenoids. In *Cucurbita maxima*, cotyledons were treated with CPTA for the induction of lycopene (FORTINO—SPLITTSTOESSER 1974). CPTA has a very marked effect upon pigment synthesis in *Cucurbita* cotyledons. A similar result was noted with EMD-IT 3233 in the case of *Cucurbita pepo* in the present study. EMD-IT 3233 is a substance used in herbicide combinations and growth regulators. When either green or etiolated cotyledons were treated with EMD-IT 3233, lycopene accumulated as the principal pigment. There was a decrease in plumule and cotyledon growth resulting from the increase in lycopene. When more lycopene was found in the tissue, there was a pronounced decrease in chlorophyll. Various hormones control the chlorophyll and carotenoid synthesis in *C. maxima* cotyledons (PENNER—WILEY 1972) and in *C. moschata* (FORTINO—SPLITTSTOESSER 1974). In the present study EMD-IT 3233 appears to act in *C. pepo* in the same way as CPTA acts in *C. moschata*. When etiolated cotyledons were treated with EMD-IT 3233 and placed in the light, chlorophyll was rapidly formed and the total amount of chlorophyll then progressively declined. Thus EMD-IT 3233 appears to inhibit chlorophyll synthesis rather than stimulate chlorophyll degradation. The cotyledons of *Cucurbita* sp. normally contain little phytofluene and a trace amount of ζ -carotene, γ -carotene, and neurospereene. EMD-IT 3233 induces the accumulation of these pigments but it may not actually stimulate the individual enzymes involved in the

synthesis of these carotenes. One pathway involved in the synthesis of β -carotene is via lycopene (HILL *et al.* 1971, THEIMER—RAU 1972). EMD-IT 3233 may stimulate the pathway to lycopene or may inhibit the pathway from lycopene to β -carotene (HSU *et al.* 1972, COGGINS *et al.* 1970), with a resulting accumulation of lycopene. Light was required for lycopene accumulation in pumpkin cotyledons and carotenogenesis is known to be affected by light (REBEIZ 1968, DOLPHIN 1970, SCHNARRENBARGER—MOHR 1970). However, lycopene does not normally accumulate in pumpkin cotyledons, but EMD-IT 3233 combined with light may initiate the functioning of the appropriate gene and enzymes to allow this rapid carotenoid production. MUMMERY—VALADON (1973) have suggested that CPTA may act as an inhibitor on light-induced carotenogenesis in the fungi *Verticillium agaricinum*.

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N, P AND K REQUIREMENT FOR TARGETTED YIELDS OF POTATO (SOLANUM TUBEROSUM L) IN MOLLISOL OF UTTAR PRADES, INDIA

Every soil-crop-climate system has its own particular nutrient release, mobilization and uptake pattern. Therefore, the crop nutrient requirement for a particular soil climatic zone needs to be determined. The evaluation of fertilizer needs for targetted yields of potato in Mollisol soil will help in rationalizing the fertilizer doses when it is in short supply for this heavy nutrient feeder vegetable crop in this area. The concept of making fertilizer recommendations for the targetted yields is based on the relationship between the initial soil-test values of the field and the nutrients applied to the soil on the one hand, and yield and nutrient uptake on the other.

The statistical lay-out, treatments and methodology adopted for the present investigation are according to the technical programme of the All-India Co-ordinated I.C.A.R. Scheme for soil-test crop response correlation (ANONYMOUS 1974). The investigation was carried out at the crop research centre during the rabi season (October—March). The soil belonged to the order Mollisol, suborder Udoll and was clay loam in texture.

The selected experimental field was divided into 4 equal strips of 8 m width, separated by 1.5 m wide channels. A strip-wise artificial fertility gradient was created by differentially fertilizing the soil and growing gradient stabilizing crops, wheat and maize, during the rabi (1973—74) and kharif (1974) seasons, respectively. In each strip 30 plots of net size $8 \times 2 \text{ m}^2$ were made.

The response of the potato variety Kufri Deva to the selected combinations of 5 level of N (0, 50, 100, 150 and 200 kg/ha), 4 levels of P (0, 22, 44 and 66 kg P/ha) and 3 levels of K (0, 41.5 and 83 kg K/ha) was studied.

Before fertilizer application and sowing of the crop, composite soil samples (0—15 cm) were taken from each individual plot and were analysed for alkaline potassium permanganate oxidizable nitrogen (SUBBIAH—ASIJA 1956), available phosphorus (OLSEN *et al.* 1954) and neutral normal ammonium acetate extractable potassium (HANWAY—HEIDAL 1952). At the time of harvesting, plant samples (both tubers and shoots) from each plot were collected. The total uptake analysis was done in selected treated plots and all control plots. Only those samples of treated plots, up to which there was an almost linear response to the nutrient element in question, were selected. Tuber and shoot samples were analysed for nitrogen, phosphorus and potassium.

Basic data for relating the nutrient requirement with the targetted yields were calculated as follows:

$$\text{Total uptake (kg)} = \frac{\text{Nutrient percentage in tubers} \times \text{tuber yield on oven dry basis (q)}}{100} + \frac{\text{Nutrient percentage in shoot} \times \text{shoot weight on oven dry basis (q)}}{100}$$

$$\text{Nutrient requirement (kg/q tuber)} = \frac{\text{Total nutrient uptake (kg)}}{\text{Tuber yield (q)}}$$

$$\text{Percentage contribution of nutrient from soil (Cs)} = \frac{\text{Total uptake of nutrient control plot}}{\text{Soil-test value of that nutrient in control plot}} \times 100$$

$$\text{Percentage contribution of nutrient from fertilizer (Cf)} = \frac{\text{Total uptake of nutrients in plot} - (\text{Soil-test values} \times \text{Cs} - 100)}{\text{Fertilizer dose}} \times 100$$

The nutrients required for targetted yields were calculated as follows:

$$\text{Nutrient in kg/ha} = [(\text{Targetted yield in q/ha} \times \text{Nutrient required in kg/q tuber}) - (\text{Soil-test value in kg/ha} \times \text{Cs})] \times 1/\text{Cf}$$

The basic data regarding the calculation of fertilizer doses for targetted yields of the potato variety Kufri Deva are presented in Table 1. For the production of one quintal of potato tubers, 0.31 kg of nitrogen, 0.06 kg of P and 1.13 kg of K were required. NEUBERGER—SANGER (1942) reported that 0.24 to 0.36 kg of nitrogen was required to produce one quintal of potato tubers. According to another report (SMITH 1968) 0.40 kg N, 0.07 kg P and 0.82 kg K

Table 1

Basic data for calculating fertilizer doses for targetted yields
of the potato variety Kufri Deva

No.	Particulars	Nitrogen (N)	Phosphorus (P)	Potassium (K)
1.	Nutrient required (kg) for production of one quintal of tubers	0.31	0.06	1.13
2.	Contribution from soil as a percentage of its available nutrient (Cs)*	25.56	37.95	120.50**
3.	Contribution from fertilizer as a percentage of its nutrient content (Cf)	27.80	8.59	290.25***

* Soil tests: Alkaline potassium permanganate oxidizable N, Olsen's P and ammonium acetate extractable K.

** Potassium available from fixed forms.

*** N P interaction and priming effect.

were required to produce one quintal of tubers. Comparing the present values with these previously reported values, the nitrogen and phosphorus requirements were almost the same but the potassium uptake in the present investigation was higher.

The contribution from the soil as a percentage of the available nutrient was 25.56% of alkaline permanganate nitrogen, 37.95% of Olsen's phosphorus and 120.50% of neutral normal ammonium acetate extractable potassium. The contribution from the soil as a percentage of the available nutrient was more than 100 in the case of potassium. This indicates that the forms of potassium which are not extractable by neutral normal ammonium acetate were available for the potato crop. Since mica, chlorite and vermiculite are dominant clay minerals (DESHPANDE *et al.* 1971) in Mollisol soils of Nainital Tarai, these soils have extensive reserves of potassium. The fixed forms of potassium, therefore, appear to be released when the readily available forms (extractable by neutral normal ammonium acetate) are exhausted by the potato crop. REDDY (1972) reported that potassium was released in these soils from an initially non-labile pool to a labile pool during the cropping season of paddy. The contribution from fertilizer was 27.80% nitrogen, 8.59% phosphorus and 290.25% potassium, when expressed as a percentage of the added nutrient. The low efficiency of nitrogen may be due to losses of this element from the soil by various processes. The low utilization efficiency of phosphorus may be attributed to the fixation of this element in the soil and also due to the fact that the soil was already well supplied with P. Thus there is considerable scope of increasing the fertilizer use efficiency. The greater than 100% contribution for potassium from fertilizer may be due to the combined effect of several factors. The interaction effect of higher doses of nitrogen and phosphorus and the "priming effect" of starter doses of potassium in the treated plots may have caused the release of soil potassium from the non-labile pool to the labile pool, resulting in increased uptake from the native soil sources by the potato crop. It was reported that the contribution from fertilizer as a percentage of its nutrient content in the case of potassium was 196.61% for maize (VATSA 1973) in Mollisol soils of Nainital Tarai. The results of the present study are in conformity of this observation.

The following simplified equations were worked out linking the fertilizer dose, targetted yield and soil test values.

I. Fertilizer N in kg/ha = $1.0850 \times \text{targetted yield (q/ha)} - 0.8946 \times \text{soil-test value (kg N/ha)}$.

II. Fertilizer P in kg/ha = $0.6950 \times \text{targetted yield (q/ha)} - 4.4695 \times \text{soil-test value (kg P/ha)}$.

III. Fertilizer K in kg/ha = $0.3842 \times \text{targetted yield (q/ha)} - 0.4097 \times \text{soil-test value (kg K/ha)}$.

The application range and the N, P and K fertilizer needs at various soil-test values for producing different targetted yields of potato, calculated by using the above relations, are given in Tables 2, 3 and 4, respectively. Since only the linear part of the response curve

Table 2*N requirements for targetted yields of potato*

Soil-test values (Alkaline potassium permanganate N, kg/ha)	Yield targets (q/ha)				
	150	200	250	300	350
	Amount of nitrogen to be added (kg/ha)				
150	28.6	82.8	137.1	191.3	245.6
200	Nil	38.1	92.3	146.6	200.8
250	Nil	Nil	47.6	101.8	156.1
300	Nil	Nil	2.9	57.1	111.4
350	Nil	Nil	Nil	12.4	66.6
400	Nil	Nil	Nil	Nil	21.9

Table 3*P requirements for targetted yields of potato*

Soil-test values (Olsen's P, kg/ha)	Yield targets (q/ha)				
	150	200	250	300	350
	Amount of P to be added (kg/ha)				
25	Nil	27.5	62.3	97.1	131.9
30	Nil	5.1	39.9	74.7	109.5
40	Nil	Nil	Nil	30.0	64.8
50	Nil	Nil	Nil	Nil	20.1
60 and above	Nil	Nil	Nil	Nil	Nil

Table 4*K requirements for targetted yields of potato*

Soil-test values (Ammonium acetate K, kg/ha)	Yield targets (q/ha)				
	150	200	250	300	350
	Amount of K to be added (kg/ha)				
90	20.8	40.0	59.2	78.4	97.6
120	8.5	27.7	46.9	66.1	85.3
150	Nil	15.4	34.6	53.8	73.0
180	Nil	3.1	22.3	41.5	60.7
210	Nil	Nil	10.0	29.2	48.4
240	Nil	Nil	Nil	16.9	36.1
270	Nil	Nil	Nil	4.6	23.8
300	Nil	Nil	Nil	Nil	11.6

has been utilized for the computation of these relationships, and fertilizer doses for targeted yields are only recommended when the resource constraint is there, extrapolations beyond the specified range of soil-test values, yield levels and fertilizer doses is not possible. These equations therefore need to be used with caution.

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ECO-PHYSIOLOGICAL EXPLOITATION OF TRITICALE SEEDS WITH PRE-SOWING TREATMENTS TO DEVELOP HARDINESS AGAINST MOISTURE STRESS

Triticale, the most important man-made cereal, which has the parental genomes of *Triticum* and *Secale*, has wide adaptability to adverse environmental conditions. *Triticale*, with its relatively improved hectolitre weight, reduced plant height, resistance to lodging, head snapping and grain shattering, and high yield, with high protein (17.5%) and lysine content (3.7%), held out great promise to agricultural scientists. Despite its wider adaptability compared to other cereals, however, this crop did not do better under rainfed conditions. Since 2/3rd of the area of India is rainfed with low moisture availability, it is therefore worthwhile to develop techniques to harden the seeds against moisture stress. Pre-sowing seed treatment are known to induce hardiness in plants against moisture stress (HENCKEL 1961, DARRA *et al.* 1973, SRIVASTAVA—KHATTRA 1975, AHLUWALIA—SRIVASTAVA 1977). This prompted the authors to carry out investigations to harden seeds of triticale against moisture stress by applying pre-sowing seed treatments. This ensures a unique improvement in crops, giving them a good start when exposed to the complex and uncontrollable conditions in the field.

Seeds of triticale cultivar TL-22 harvested during 1975 and procured from the Department of Plant Breeding, Punjab Agricultural University, Ludhiana, were used in the present studies. Healthy seeds of approximately the same size were used in the experiments. The seeds were stored in air-tight polythene bags in the refrigerator at low temperature ($12 \pm 1^\circ\text{C}$) in order to keep the seeds at the same metabolic stage throughout the experimental period. Before carrying out the germination test, the seeds were surface sterilized with 0.1% mercuric chloride and washed thoroughly with distilled water before use. Petri dishes with filter paper were sterilized in the autoclave at 15 lb pressure. All the experiments were replicated three times with twenty five seeds in each replicate and all the germinations were carried out at

22 \pm 1°C. Moisture stress of 3, 5, 6, 8 and 10 atm was built up with polyethylene glycol 6000 (PEG) using the table given by ZUR (1966) and all the germination tests were carried out under these stress conditions. Periodical germination counts were recorded after every 24 hr and were continued for 120 hr. The germination rate was determined by calculating the germination relative index (SRIVASTAVA—SAREEN 1972). Total germination counts were made after 120 hr. In order to maintain uniformity, seeds with 2 mm radicle length were considered germinated. The vigour index was calculated on the basis of total germination percentage and coleoptile length at 120 hr of seedling growth (ABDUL BAKI—ANDERSON 1973).

Pre-sowing treatments. Seeds were given one cycle of wetting and drying for different periods by soaking them in water for 3, 6 and 9 hr and drying to the original seed moisture content before sowing. In other treatments two and three cycles of wetting and drying were given to the seeds. The pre-conditioned seeds, as mentioned above, were germinated under normal and stress conditions as specified earlier. The germination percentage and the germination relative index (GRI) were determined in these treated samples and compared with the control (without any pre-sowing soaking treatments). Five day old seedlings were transplanted to 200 ml plastic beakers containing nutrient solution prepared according to ARNON—HOAGLAND (1940). In order to develop the respective moisture stress, the relative amount of PEG was added to the nutrient solution in the manner described above. The respective moisture stress was maintained in the beakers by adding water up to a marked point after every 24 hr. Water evaporation was reduced by covering the beaker with a polythene sheet with fifteen holes to accommodate the seedlings. The seedlings were raised in the Arnon and Hoagland solution for 6 days in a growth chamber at 22 \pm 1°C and 75–80% relative humidity and with continuous light with an intensity of 12,000 lux provided by incandescent and fluorescent lamps. The solution was aerated every day. After 6 days the Arnon and Hoagland solution was replaced by fresh nutrient solution equilibrated to different moisture stress conditions according to ZUR (1966). The seedlings were grown in the respective stress media for five days and then removed to measure the root-shoot length and the dry weight. Biochemical determinations were done on all the samples as reported in the text.

Dry seeds at 9–10% seed moisture were exposed to ultraviolet radiation with a 30 watt UV lamp placed at a distance of 45 cm from the samples to be exposed. The exposures were given for 15, 30, 45, 60, 75, 90, 120, 180, 240 and 300 min. Seeds exposed to UV were subjected to the germination test under moisture stress conditions along with the control.

Seedlings were also raised from seeds given exposure and all the physiological and biochemical determinations were made as described earlier.

The seeds were exposed to temperatures of 30, 40, 50, 60 and 70°C for different durations in incubators before subjecting them to the germination test under moisture stress conditions.

Protein estimation

Extraction. Leaves from seedlings raised in stressed and non-stressed nutrient solution were extracted in ethyl alcohol. After centrifugation, the clear supernatant was precipitated with 15% trichloroacetic acid (TCA) and left for 24 hr at 4 \pm 1°C. After thorough washing with boiled ethanol : ether (3 : 1, v/v) solution, the precipitate was treated with 0.3 N NaOH and kept at 30°C for 18 hr. The residue obtained after centrifugation was washed once again with 0.3 N NaOH and centrifuged. After the necessary dilutions of the supernatant with 0.3 N NaOH, a specific quantity of the supernatant was taken for protein estimation.

Protein was estimated following the method of LOWRY *et al.* (1951) using Folin-Ciocalteu phenol reagent for developing colour. The optical density of the reaction mixture was read at 570 nm and the mg equivalent of the protein content was calculated by comparing with the standard curve using serum albumen.

Free proline content. Free proline was determined by the modified method given by SINGH *et al.* (1973). Fresh leaves were crushed in 6 ml of M.C.W. mixture (methanol : chloroform : water, 12 : 5 : 1) and centrifuged. The supernatant collected was made up to 10 ml with M.C.W. In the final volume 6 ml of chloroform and 4 ml of distilled water was added. The mixture was allowed to stand for 5 minutes in a separating funnel. The lower layer (containing pigments) was rejected and the upper white turbid layer was put into a test-tube and made up to 10 ml with distilled water. After shaking thoroughly for 10 minutes, 5 ml of glacial acetic acid and 5 ml of acid ninhydrin reagent (in glacial acetic acid and orthophosphoric acid) were added and boiled vigorously for 45 minutes till a red colour developed. The mixture was cooled at room temperature and 5 ml of benzene was added to it. The mixture was shaken thoroughly in the separating funnel and left for some time for the layers to settle down. The lower layer was discarded and the upper layer was collected for recording the

optical density of the colour in a Speckol colorimeter at 515 nm wavelength, using benzene as blank. The quantity of proline was calculated using the standard curve.

Pre-sowing seed treatments regulate the early metabolism of seeds without any damage to seed germination, provided the treatments given are within the safe limits. Dehydration of the embryo after pre-sowing soaking does not cause any adverse effect on the seeds if it is done prior to DNA replication. It is safe if it is restricted to the inhibition phase when only protein synthesis is in operation and probably one of the proteins is DNA polymerase (ROBERTS—OSBORNE 1973, HALLAM 1973).

As observed in triticale, seed germination decreased with increasing levels of moisture stress from 0 to 10 atm (Table 1). A similar decrease is also noticed in the germination relative index (Table 3). The probable reason for this decrease appears to be the non-availability of free water to be imbibed by the seeds (UHVITS 1946, AYERS 1952, SHAH—LOOMIS 1965). The low availability of water subjects the seeds to moisture stress, inducing the synthesis of abscisic acid (SIVAKUMARAN—HALL 1978) and thus reducing germination and germination rate. This needs further verification.

Seed soaking in water and dehydrating to the original seed moisture content before planting produced some improvement in total germination (Table 1) and germination relative index (Table 3) when the duration of soaking was increased from 3 to 6 hr and then to 9 hr in one cycle. The improvement in germination in seeds given pre-sowing soaking in water

Table 1
*Germination of triticale seeds given one cycle of soaking
in water for different durations*

Soaking duration (S) (hr)	Moisture stress (T) (atm)				Means
	T ₀	T ₃	T ₅	T ₈	
S ₀	70	56	35	20	45.2
S ₃	60	45	40	27	43.0
S ₆	67	50	42	30	47.2
S ₉	75	70	45	42	58.0
Means	68.0	55.2	40.5	29.7	

Table 2
*Germination of triticale seeds given two cycles of soaking
in water for different durations*

Soaking duration (S) (hr)	Moisture stress (T) (atm)				Means
	T ₀	T ₃	T ₅	T ₈	
S ₀	70	56	35	20	45.2
S ₃	52	42	32	23	37.2
S ₆	50	17	17	15	21.4
S ₉	67	30	25	18	35.0
Means	59.7	36.2	27.2	19.0	

Table 3

Germination relative index of tritcale seeds given one cycle of soaking in water for different durations

Soaking duration (S) (hr)	Moisture stress (T) (atm)				Means
	T ₀	T ₃	T ₅	T ₆	
S ₀	77	57	52	18	51.0
S ₃	63	35	32	13	35.7
S ₆	65	51	35	22	43.2
S ₉	67	55	37	27	46.5
Means	68.0	49.5	39.0	20.0	

Table 4

Germination relative index of tritcale seeds given two cycles of soaking in water for different durations

Soaking duration (S) (hr)	Moisture stress (T) (atm)				Means
	T ₀	T ₃	T ₅	T ₆	
S ₀	77	57	52	18	51.0
S ₃	55	18	20	10	25.7
S ₆	53	12	10	9.0	21.0
S ₉	61	32	18	10	30.2
Means	61.5	29.7	25	11.7	

for 9 hr in one cycle over the unsoaked seeds has been visualized to be the synthesis of protein as the pre-requisite to start the chain reactions leading to germination. The protein synthesized during earlier stages is probably DNA polymerase, which is evidenced by the start of DNA replication in the second phase (ROBERTS—OSBORNE 1973, HALLAM 1973). The decrease in the total germination and germination relative index with the increase in the number of soaking cycles from one to two (Tables 2, 4) might possibly have coincided with the replication of DNA occurring during the late soaking, so the dehydration of seeds at this stage will usually damage the normal metabolic pathway (ROBERTS—OSBORNE 1973, HALLAM 1973). The improvement in total seed germination and germination relative index in the unfavourable seed bed environment as a result of early soaking and drying at the optimal period probably helped in avoiding the stress effect in the early critical growth stage. The failure of seeds to germinate at 8 and 10 atm moisture stress even after giving the pre-sowing soaking treatments at the optimal time may possibly be because of the inability of seeds to draw water under this tension (WILLIAMS—SHAYKEVICH 1970).

Pre-conditioning of dry seeds by exposing them to a temperature of 40°C for 6 hr before sowing induced hardness against moisture stress to certain critical levels (3, 5 and 6 atm), which is evidenced by the higher germination, germination rate and vigour index over the control (Table 5). This suggests the presence of certain thermosensitive organic molecules which undergo changes in their structural configuration, giving a resistant character

to seeds against moisture stress. This needs more clarification before assigning any definite cause to this effect. The other possibility, suggested by SIMON—RAJA HARUP (1972) is related to the possibility of reduction in the solute leakage by making the seeds imbibe water slowly, because during drying the cell membrane loses its integrity, which is re-established during imbibition, thus causing slow imbibition. This could possibly help to minimise solute leakage and therefore store the essential metabolites to be utilized in effective turnover during germination and seedling growth even under stress conditions, which cannot be ruled out.

Pre-sowing exposure of dry seeds to ultraviolet light for 60 min also induced hardiness in seeds, so the germination, germination rate and vigour index of the seeds showed an increase as compared to unexposed seeds when subjected to different degrees of moisture stress (Table 6).

Table 5

Germination percentage, germination relative index and vigour index of triticales seeds exposed to 40 °C for 6 h

Moisture stress (atm)				
	0	3	5	6
Germination percentage				
unexposed	70	56	36	20
exposed	88	84	60	52
Germination relative index				
unexposed	78	57	50	16
exposed	83	67	58	16
Vigour index				
unexposed	476.0	15.12	5.04	1.04
exposed	500.0	36.90	10.8	6.0

Table 6

Germination percentage, germination relative index and vigour index of triticales seeds exposed to ultraviolet (UV) radiation for 60 min.

Moisture stress (atm)				
	0	3	5	6
Germination percentage				
unexposed	68	60	52	24
exposed	92	88	76	60
Germination relative index				
unexposed	76	63	42	31
exposed	108	93	64	56
Vigour index				
unexposed	460	20	12	4
exposed	770	118	30	16

Table 7

Protein content in $\mu/100$ mg leaves obtained from seeds given pre-sowing ultraviolet (UV) exposure for 60 min

Moisture stress (atm)						
	0	3	5	6	8	10
Exposed	3640	4500	4800	5080	5546	6240
Unexposed	3540	3840	4020	4320	4700	5660

This probably acted at the chromosomal level and altered the nucleic acid metabolism prior to imbibition. Thus, it probably made the seeds more able to complete the initial phase of germination, which is most critical to the seeds when subjected to moisture stress. This explores the further scope of identifying the critical change associated with the hardening in response to UV-exposure.

Further work with regard to the biochemical analysis of seedlings raised from seeds given pre-sowing treatments provides some interesting facts which can probably form the basis of hardening induced in seeds. It was observed that there was an increase in protein content parallel to the increase in moisture stress during the germination of seeds. There was an increase in protein content with the increase in moisture stress and the seedlings raised from seeds hardened by pre-sowing soaking in water gave higher protein contents than the control at the successive moisture stress levels, following a general trend of increase with the increase in moisture stress (Fig. 1). This does not confirm the observations made by WEST (1962), who reported a decrease in protein content with the increase in moisture stress. He reported a decrease in the polymerase formation associated with the reduction in mRNA

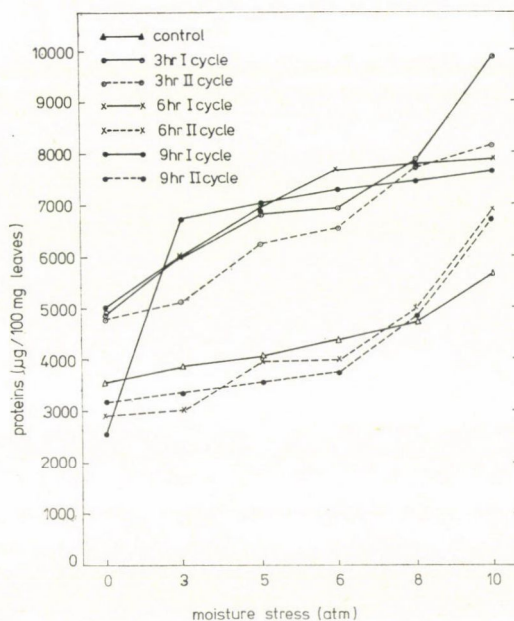


Fig. 1. Protein content in the leaves of seedlings raised from *Triticale* seeds soaked in water for various durations and cycles and germinated at $22 \pm 1^\circ\text{C}$ under moisture stress varying from 0 to 10 atm

and protein synthesis parallel to the increase in moisture stress. The increase in protein content in the initial stages of seedling growth after an increase in moisture stress suggests the likelihood of the stimulation of long-lived mRNA under moisture stress conditions. The relatively high values of protein in seeds given one cycle of wetting and drying suggest that during the process of hardening the polysome formed becomes pre-conditioned, so its degradation under stress conditions is probably reduced compared to unhardened seeds HENCKEL (1970) has also reported that there was higher incorporation of ^{15}N amino acid into proteins during and after drought and less polysome degradation during this period in hardened as compared to unhardened plants. The hypothesis suggested above is further strengthened by the observation that the protein content decreased in seedlings obtained from seeds given two cycles as compared to one cycle of wetting and drying. This decrease in protein content in two cycles of wetting and drying might possibly be a result of decreased seedling potentiality to synthesize protein and increased protein degradation resulting in the release of amino acids, which trigger the diastase activity causing an increase in soluble carbohydrates leading to increased respiration (NOTHES 1978). Thus, an increase in protein in response to hardening of the seeds against moisture stress appears to be the key metabolic event which needs to be tested further in other crops too.

The ultraviolet exposure of the seeds followed by their hardening produced an increase in the protein content of the seedlings (Table 7) as compared to the unexposed seeds. It therefore strengthens the view that the hardening induced in the seeds is associated with protein synthesis. The most logical explanation appears to be in the maintenance of polysome components, keeping it intact and active. However, more experiments need to be conducted to pinpoint specifically the basic metabolism in relation to hardening of seeds.

Another parameter which appeared to have some specific relationship with the hardening of seeds against moisture stress is their proline content. The normal increase in the proline content with the increase in moisture stress was magnified in UV hardened seeds (Fig. 2). This corresponded with the degree of hardening in the seeds and was reflected in the overall germination, germination rate and seedling vigour (Table 6).

Thus, the proline content of seedlings can also form the basis for hardening against moisture stress. The present studies have revealed the simultaneous increase in protein and

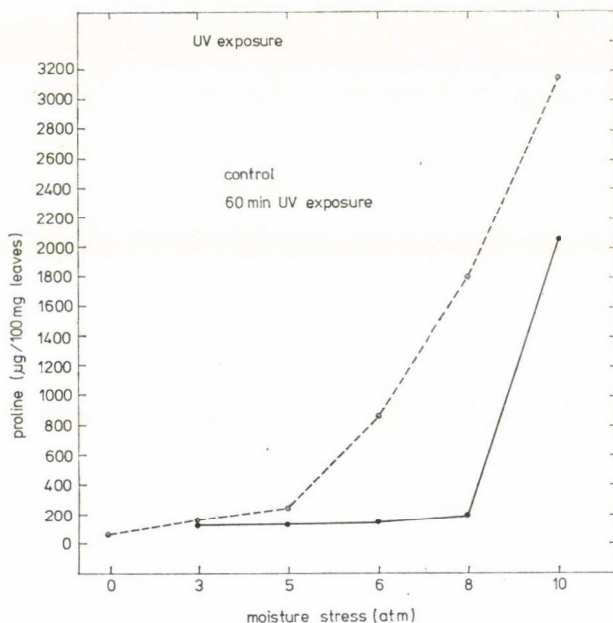


Fig. 2. Proline content in leaves obtained from seedlings raised from *Triticale* seeds exposed to ultraviolet radiation for 60 min and germinated at $22 \pm 1^\circ\text{C}$ under moisture stress varying from 0 to 10 atm

proline content of seedlings with the increase in moisture stress, with relatively higher magnitude in hardened seeds. So proline accumulation as reported in the present study does not seem to be due to protein breakdown but possibly due to its de novo synthesis. Similar conclusions have been drawn by PÁLFI—JUHÁSZ (1971), PROSTSENKO *et al.* (1968) and STEWART *et al.* (1966), who have also suggested that the increase in proline content was not due to protein breakdown but due to the de novo synthesis of proline in *Solanum laciniatum*.

At 0 atm moisture stress there was also a relatively higher accumulation of proline in the leaves of the seedlings obtained from seeds given 6 hr soaking followed by drying in one and two cycles (150 and 122 $\mu\text{g}/100$ mg leaf samples, respectively) as compared to the leaf proline obtained from unsoaked seeds (81 $\mu\text{g}/100$ mg leaf sample). Seeds soaked for 3 and 9 hr in one and two cycles had leaf proline contents of 366.6, 260.0 μg (3 hr soaking in one and two cycles respectively), 145.0 and 134.2 μg (9 hr in one and two cycles, respectively) against 129 μg proline/100 mg leaf in the samples obtained from unsoaked seeds at 5 atm moisture stress. At 6 atm, the leaf proline content of the seedlings obtained from seeds soaked for 6 hr in one and two cycles was 552.6 and 403.2 μg and for those soaked for 9 hr in one and two cycles, it was 852.0 and 759.0 μg respectively against 201 $\mu\text{g}/100$ mg leaves obtained from seedlings raised from unsoaked seeds. At 10 atm moisture stress the leaf proline content of the seedlings obtained from seeds which were given 9 hr water soaking followed by drying in one cycle was 2169 $\mu\text{g}/100$ mg leaves, which was higher than the leaf proline of seedlings obtained from the unsoaked control seeds, which had a value of 2064 $\mu\text{g}/100$ mg leaves. The uniform increase in leaf proline content of the seedlings obtained from seeds given pre-sowing soaking in water followed by drying before sowing suggests the possibility of its involvement as protectant against moisture stress. It could thus act as an indicator for determining the magnitude of hardness developed in the seeds.

Seeds hardened against moisture stress by exposing them to ultra violet rays before sowing also gave a high proline content in the leaves of seedlings raised under moisture stress (Fig. 2). The seedlings of the hardened seeds contained 162, 243, 864, 1812 and 3168 μg proline/100 mg leaves against 120, 129, 144, 201 and 2064 μg proline/100 mg leaves in seedlings obtained from unexposed seeds raised at a moisture stress of 3, 5, 6, 8 and 10 atm respectively (Fig. 2). This further strengthens our hypothesis that pre-sowing hardening of seeds against moisture stress is probably triggered by specific treatments inducing an increase in proline content along with protein in the growing seedlings under moisture stress conditions.

Based on the evidence collected, it appears that the two components specific to hardening, protein and proline, have different metabolic pathways, independent of their respective syntheses. After reviewing all the aspects in relation to the respective treatments, it appeared that ultraviolet exposure of the seeds for 60 min., temperature exposure of 40°C for 6 hr and water soaking for 9 hr in one cycle were the best treatments to induce hardening against moisture stress in seedlings when subjected to moisture stress.

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CHANGES IN GROWTH, PHOTOSYNTHESIS AND FAT CONTENT OF SOME OIL PRODUCING PLANTS OVER A RANGE OF SALINITY STRESSES

In arid saline regions, the cultivation of crop plants can be mainly achieved either after washing out excess salts by repeated flooding with fresh water, or by selecting plants adapted to such saline soil conditions. Since sufficient amounts of fresh water are not always available, the second alternative seems to be more applicable. Therefore a considerable number of investigations were made to study the effect of salinization treatments on the growth and production of some glycophytic crop plants (POLJAKOFF-MAYBER—GALE 1975, BERNSTEIN 1975), as well as on halophytic and succulent plants (JENNINGS 1968). Consequently some metabolic processes were also subjected to investigation.

As regards photosynthesis and pigment biosynthesis, it has been found that in glycophytic plants, these processes were generally reduced in proportion to the salt concentration (GALE—POLJAKOFF-MAYBER 1970, HOFFMAN—PHENE 1971, AHMED *et al.* 1978). In halo-

phytes and succulent plants, on the other hand, low concentrations of salts do not reduce, and may even enhance photosynthesis and pigment biosynthesis (GALE—POLJAKOFF-MAYBER 1970, SHOMER-ILAN—WAISEL 1973, WILLERT 1973, WINTER 1974, DOWNTON—TOROKFALVY 1975, TIKU 1976).

The fat content has not been intensively studied in relation to salinity. However, some correlations were found between the lipid content and salinity in some higher plants (KUIPER 1969, TWERSKY—FELHENDLER 1973) as well as in the halophytic alga *Dunaliella* (BEN-AMOTZ—AVRON 1973, FRANK—WEGMANN 1974). It was assumed that lipids which could be synthesized via photosynthesis (KAUSS 1967, FRANK—WEGMANN 1974) might act as osmoregulators (BEN-AMOTZ—AVRON 1973).

The need to select some plants to be cultivated in saline soils induced the necessity to conduct a series of investigations using Egypt's economic plants to test their ability to tolerate salinity and to follow the changes that might take place in their physiological activities during salinization treatments. From some of these investigations (AHMED *et al.* 1977, 1978, HEIKAL *et al.* 1979) an impression was obtained that oil producing plants generally exhibit a certain degree of tolerance to salinity conditions. Accordingly it was intended to follow the growth and some metabolic activities of this group of plants when subjected to salinization treatments. In this paper the effects of salinization treatments on growth, photosynthesis and fat content of castor bean, sunflower and flax plants were studied.

Water cultures as described by RADI *et al.* (1973) were principally used to provide controlled concentrations of the nutritive elements as well as of the salinizing agent. Three oil producing plants, namely castor bean (*Ricinus communis*), sunflower (*Helianthus annuus*) and flax (*Linum usitatissimum*) were tested in this investigation. After being left to grow on full nutrient medium (PFEFFER 1900) for about 20 days the seedlings were transferred to solutions of Na_2SO_4 at varying concentrations (0.0—100 meq). They were then left to grow for another 60 days. In order to keep the nutrient elements and the salinizing agent as close to their initial concentrations as possible, the culture solutions were renewed every three days.

At the end of the experimental period, the growth parameters, namely leaf area and dry weight per plant, were estimated by the method recommended by BREMNER—TAHA (1966). The total photosynthetic pigments were determined colorimetrically by the method recommended by METZNER *et al.* (1965). The photosynthetic activity was obtained by the determination of the radioactivity (cpm/g leaf dry weight) after ^{14}C light fixation, using in principal the technique applied by BASSHAM—CALVIN (1957) and the apparatus described by METZNER (1968). The fat contents in the various plant parts (leaves, stems, roots) were quantitatively extracted in petroleum ether (b.pt. 60—80°C) using the weight method given by MEARA (1955) and then calculated as mg/g dry weight of the corresponding plant tissue. The data were always statistically analysed for the least significant difference as given by SNEDECOR—COCHRANE (1967).

Table 1

Effect of different levels of sodium sulphate, when supplied for 60 days on the leaf area (dm^2/plant) and dry weight (g/plant) of castor bean, sunflower and flax plants

Salinization treatment (meq Na_2SO_4)	Castor bean		Sunflower		Flax	
	Leaf area	Dry weight	Leaf area	Dry weight	Leaf area	Dry weight
0.0	8.10	14.20	10.10	13.50	24.50	7.15
20	9.70*	16.60*	15.20*	15.50*	29.3*	8.64*
40	13.90*	19.40*	20.00*	18.90*	36.00*	10.51*
60	6.70*	12.60*	8.60*	12.40*	17.70*	4.89*
80	5.20*	10.20*	5.20*	10.60*	12.20*	3.76*
100	4.20*	8.90*	2.90*	8.90*	4.40*	2.84*
LSD 1%	0.80	0.75	0.80	0.49	1.60	0.56

* Highly significant differences as compared with control.

Table 2

Effect of different levels of sodium sulphate, when supplied for 60 days, on total content of photosynthetically active pigments (mg/g leaf dry weight) and relative photosynthetic activity (cpm/g leaf dry weight) of castor bean, sunflower and flax plants

Salinization treatment (meq Na_2SO_4)	Castor bean		Sunflower		Flax	
	Pigments (mg/g leaf dry weight)	Photo-synthesis ($\times 10^6$ cpm/g leaf dry weight)	Pigments (mg/g leaf dry weight)	Photo-synthesis ($\times 10^6$ cpm/g leaf dry weight)	Pigments (mg/g leaf dry weight)	Photo-synthesis ($\times 10^6$ cpm/g leaf dry weight)
0.0	7.68	5.05	19.10	11.97	29.40	16.60
20	9.34*	7.20*	20.70*	12.98*	33.40*	18.35*
40	15.88*	11.65*	25.29*	25.30*	38.98*	22.80*
60	15.14*	6.10*	17.06*	11.13*	27.90	16.10
80	8.05*	3.36*	12.96*	10.08*	24.92*	10.32*
100	4.40*	1.67*	11.63*	9.95*	19.28*	7.22*
LSD 1%	0.09	0.26	1.60	0.38	1.62	0.7

* Highly significant differences as compared with control.

Table 3

Effect of different levels of sodium sulphate, when supplied for 60 days, on the fat content (mg/g dry weight) of the principal plant parts (leaves, stems, roots) of castor bean, sunflower and flax plants

Salinization treatment (meq Na_2SO_4)	Castor bean			Sunflower			Flax		
	Leaves	Stems	Roots	Leaves	Stems	Roots	Leaves	Stems	Roots
0.0	58.0	33.0	13.0	81.0	42.3	20.0	101.0	61.7	45.0
20	83.3*	44.6*	20.1*	97.4*	48.0*	22.4	123.3*	91.7*	53.0*
40	100.0*	56.6*	24.3*	102.6*	53.2*	28.0*	160.0*	103.7*	55.3*
60	76.3*	52.0*	16.6*	93.6*	46.0*	32.0*	130.0*	100.0*	58.0*
80	70.7*	41.4*	15.2	88.0*	43.6	33.1*	130.0*	71.0*	61.3*
100	63.7*	26.6*	14.0	82.6	40.6	35.2*	121.0*	65.0	64.0*
LSD 1%	4.5	4.3	3.0	4.3	3.0	4.3	6.2	4.5	4.3

* Highly significant differences as compared with control.

Salinity affected the different physiological activities of castor bean, sunflower and flax in various ways.

Growth parameters. The results in Table 1 reveal that the values of leaf area and dry weight of each of the three plants tested, increased significantly with the rise of salinization up to the level 40 meq Na_2SO_4 , where these two growth parameters exhibited their maximum values. Above this the value of these growth parameters decreased consistently with the rise in salinization up to the highest level used. In spite of the similarity in trends observed in the three plants, the magnitudes of these two parameters depended mainly on the plant tested. Accordingly it can be seen that, irrespective of the salinization level used, flax exhibited comparatively the highest values of leaf area and at the same time the lowest values of dry weight compared with those of castor bean and sunflower plants.

Pigment content and photosynthetic activity. The results in Table 2 reveal that the total pigment content (mg/g leaf dry weight) as well as the relative photosynthetic activity (cpm/g leaf dry weight) of each of the three plants tested, increased significantly with the rise of salinization up to the level 40 meq Na_2SO_4 , where they reached their maximum values. Above this the values of these two parameters diminished to reach their minimum at the highest level used. It is also noticeable that flax exhibited higher values of pigment content and photosynthetic activity than those of either castor bean or sunflower at all salinization levels, except at the levels 40 and 100 meq in the case of photosynthetic activity.

Fat content. From the results in Table 3 it can be seen that the fat contents of the principal plant organs (leaves, stems and roots) of each of the three plants tested, increased significantly with the increase of Na_2SO_4 concentration in the nutritive medium up to the level of 40 meq Na_2SO_4 , where they almost reached their maximum contents. Above this the fat content tended to decrease with the rise in the salinization level, but they remained higher than those of the control plant, even under the highest salinization level used, except in the case of stems of castor bean and sunflower. In addition it can be generally observed that in the three plants tested, irrespective of the salinization level used, the leaves always exhibited the highest fat content and the roots the lowest one. Also, it is worth noting that the principal parts of the flax plant generally exhibited higher fat contents compared with those of either castor bean or sunflower plant.

The dominant increase in the values of growth parameters, pigment content, photosynthetic activity and fat content, observed with the three oil producing plants after they were moderately salinized, is generally in accordance with the results obtained previously by AHMED *et al.* (1977, 1978) using cotton and safflower plants. Other authors have also recorded a stimulation in growth and photosynthesis (JENNINGS 1968, GALE—POLJAKOFF-MAYBER 1970, SHOMER-ILAN—WAISEL 1973, WILLERT 1973, WINTER 1974). However these authors used mainly halophytic and succulent plants. In glycophytic plants, on the other hand, salinization generally reduced photosynthesis in proportion to the salt concentrations (GALE *et al.* 1967, HOFFMAN—PHENE 1971).

The significant increase in the fat content which was observed in the test plants after salinization even with the highest concentration of Na_2SO_4 used, is in accordance with the results obtained by TWERSKY—FELHENDLER (1973) on the cotton plant. They recorded a direct relation between the salinity of irrigation and lipid concentration. Applying another technique and using a series of five stocks of grape varieties with different salt tolerance, KUIPER (1968) found that the content of lipids increased with increasing capacity for uptake of chloride and salt tolerance. In another experiment with bean, KUIPER (1969) reported that the addition of different lipids increased the uptake of chloride to the root. The observed salt tolerance of these oil producing plants, as well as the enhancement in their activities after salinization, which appear to be general features of the oil producing plants tested, strengthen the impression that these plants may have their own mechanism(s) to counteract at least the effect of mild salinization treatments. This(these) mechanism(s) could be coordinated with the biosynthesis of fats or a certain fat fraction. In accordance with this, FRANK—WEGMANN (1974), working with the halophytic alga *Dunaliella*, found that an increase in ion content in the nutritive medium was always associated with an increase in glycerol biosynthesis. They accepted the assumption made by BEN-AMOTZ—AVRON (1973) that the increase in glycerol synthesis in the halotolerant *Dunaliella* is a means of osmoregulation mechanism. The formation of glycerol is assumed to take place via photosynthesis (KAUSS 1967, FRANK—WEGMANN 1974). Hence, the distribution of light-fixed radioactive carbon among the various metabolic activities, as well as the fractionation of fats in the various plant parts, to detect if there is a preferential synthesis and accumulation of a certain fraction during salinization treatment, could be of special importance. The elucidation of these two problems, which is now in progress, may share in throwing some light on the mechanism by which these oil producing plants can counteract the toxic effect of at least mild salinity conditions. In addition this assumption must be tested with other oil producing plants.

Apart from these discussions it can generally be said that these three oil producing plants could not only tolerate moderate salinization levels, but they also exhibited better growth, which was associated with a relatively higher fat content. Thus, it can finally be said that these plants could be of special economic importance for cultivation in saline soils.

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SEASONAL NODULE ACTIVITY PROFILE OF FIELD GROWN SOYBEANS

The advent of the acetylene reduction technique has provided a relatively rapid and inexpensive method of assessing the biological nitrogen fixation under field conditions (STEWART *et al.* 1967, HARDY *et al.* 1968). Several workers (HARDY *et al.* 1968, SLOGER 1969, HARPER 1971, MAGUE—BYRRIS 1972, LAWN—BRUN 1974, and others) have used this technique to characterize the symbiotic nitrogen fixation of soybean [*Glycine max* (L.) Merr.] plants in the field over the growing season. There appears to be a lack of conformity in the results of different investigators regarding the stage of plant growth at which nitrogenase activity reaches its peak, as well as the stage at which it starts declining. LAWN—BRUN (1974) reported that the nitrogenase activity in the nodules reached a maximum near the end of flowering and then declined markedly during the early bean development. HARDY *et al.* (1968), however, found maximum nitrogenase activity during bean development and it did not decline until after bean development was complete.

Considering the lack of conformity in the earlier findings it was considered desirable to conduct additional studies examining the seasonal nitrogenase activity profile of soybeans.

Nodulated roots for the study were obtained from a field planting of soybeans [*Glycine max* (L.) Merr. cv. Lee] on the Fort Valley State College farm. The farm is located 32°34' N, 83°52' W and comprises the Norfolk fine sand type of soil. The seeds were planted in 90 cm wide rows after inoculation with commercial inoculum. The plants were grown without irrigation and standard cultural practices were followed in their management.

Samples were taken regularly from 13th July (pre-flowering stage) till near maturity to determine the number, dry weight and acetylene reduction activity of the nodules. Sampling dates were adjusted so that samples were taken only on clear days between 11 am and 3 pm. Twenty randomly selected plants were dug at each sampling date for the study. The tops were cut and the roots were inserted into 50 ml syringes adjusted airtight to 47 ml. The roots were incubated at room temperature after introducing 3 ml of acetylene generated from CaC_2 in distilled water. A 1 ml sample was withdrawn after 60 minutes and analysed for ethylene by gas chromatography. Following incubation, the volume of the roots was measured and subtracted from the syringe volume to obtain the volume of the incubation mixture. The nodules were then separated from the roots, washed, counted and dried to a constant weight in a forced air oven at 70°C.

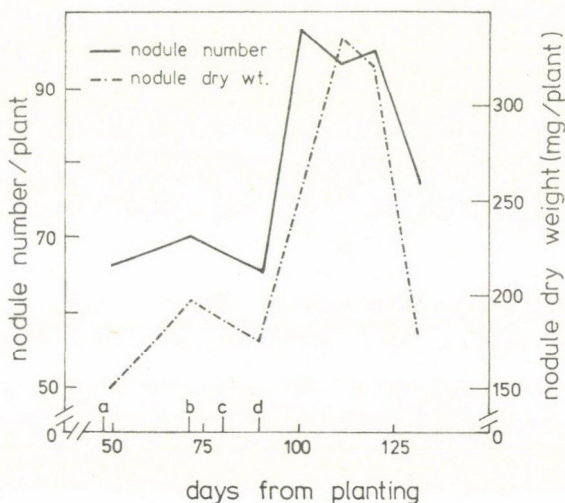


Fig. 1. Seasonal variation in nodule number and nodule dry weight in soybeans (a = Pre-flowering; b = Full bloom; c = Pod development and d = Bean development)

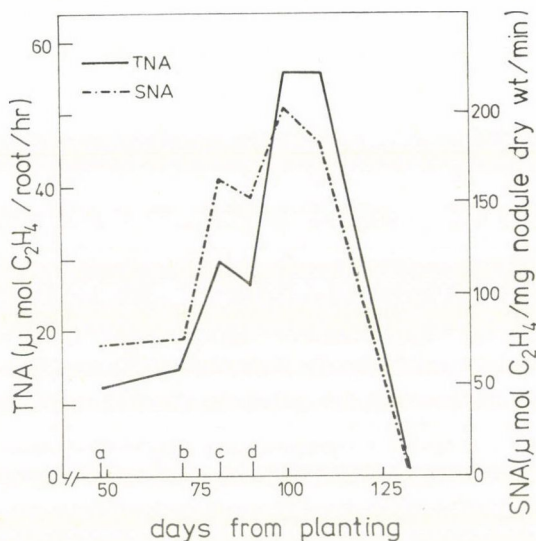


Fig. 2. Seasonal variation in acetylene reduction activity in soybeans (a = Pre-flowering; b = Full bloom; c = Pod development and d = Bean development)

The nitrogenase activity was expressed as (a) total nitrogenase activity ($\mu\text{mol C}_2\text{H}_4/\text{root/hr}$) and (b) specific nitrogenase activity ($\mu\text{mol C}_2\text{H}_4/\text{g nodule dry wt./hr}$).

The data were evaluated statistically by analysis of variance (F-test) to determine if the variables measured differed significantly during the growing season.

Figure 1 shows the seasonal profile of the number and dry weight of nodules for field grown soybeans. The nodules averaged 66.2 per plant and weighed 149.2 mg at the pre-flowering stage. There was no significant change in either the number or dry weight of nodules between the pre-flowering and the pod development stage. However, both parameters registered significant gains as the plant entered into the bean development phase of growth. Nodule number reached a maximum of 97.9 per plant and nodule dry weight reached a maximum of 336.9 mg per plant.

The seasonal profile of total and specific nitrogenase activities (TNA and SNA) of field grown soybeans is shown in Fig. 2. TNA and SNA values for the soybean plants at the pre-flowering growth stage averaged $12.42 \mu\text{mol C}_2\text{H}_4/\text{root/hr}$ and $74.07 \mu\text{mol C}_2\text{H}_4/\text{g nodule dry wt./hr}$, respectively. TNA increased in two distinct steps, first during pod development and again during the bean development stage. The TNA increase during pod development was primarily due to an increase in the SNA activity, while the TNA increase during bean development was due to an increase in the nodule dry weight. The peak values for TNA and SNA amounted to $56.12 \mu\text{mol C}_2\text{H}_4/\text{root/hr}$ and $235.58 \mu\text{mol C}_2\text{H}_4/\text{g nodule dry wt./hr}$, respectively. Nitrogenase activity started declining as the bean development approached completion. The data presented herein seem to give credence to the findings of HARDY *et al.* (1968) with respect to the seasonal profile for nitrogenase activity in soybeans.

The soybean plant requires maximum amounts of nitrogen for bean development (OHLROGGE—KAMPRATH 1968). Maximum nitrogenase activity during this period suggests a close association between the level of nitrogenase activity and the demand for nitrogen by the plant.

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EFFECT OF N-DOSES, N-FORM AND DAY TEMPERATURE ON NITRATE ACCUMULATION IN SWEET PEPPERS

The principal forms of inorganic nitrogen in plant tissues are nitrate, nitrite and ammonia. The concentrations of all three may vary considerably, but in general, nitrite accumulation is rare and the concentration of ammonia is relatively low (HEWITT *et al.* 1957). The concentration of nitrate in plants is always in a dynamic state, since it represents the difference between rates of absorption and rates of assimilation within the plant.

Nitrate accumulation in plant tissues is greatly affected by the concentration of nitrate ion in the soil (MINOTTI 1975). Since soil nitrates are controlled by the mineralization of organic nitrogen and the nitrification of inorganic forms, it is considerably affected by the nitrogen form used in chemical N-fertilization. MAYNARD *et al.* (1976) and CANTLIFFE (1972a, b) mentioned that the accumulated nitrates in beet roots and spinach leaves were increased by increasing levels of N-application.

SPLITTSTOESSER—VANDEMARK (1974) applied 22, 45, 112 or 448 kg N/ha to lettuce, mustard, tomato, pepper and other crops. The results indicated that total protein and fresh weight increased with increasing N-levels, especially in mustard. Nitrate levels in beet roots and pepper fruits were low at all levels of soil nitrogen and no nitrates were found in tomato fruits at any level. The highest level of nitrate in any crop was 1200 ppm in mustard and 3000 ppm in spinach.

CANTLIFFE (1973) indicated that nitrate accumulation was affected by genetic factors and plant organs. The NO_3-N concentration was higher in spinach leaves, while beet roots accumulated less NO_3-N than the leaves. MAYNARD *et al.* (1976) mentioned that the NO_3-N concentration in lettuce ranged from 0.11 to 1.69% based on dry weight, according to the variety, growing season, plant stage and levels of N-application. Experiments carried out by HOFF—WILCOX (1970) on tomato showed that the maximum NO_3-N concentration reached 1100—1510 ppm in leaves and 46—50 ppm in fruits based on fresh weight. The highest nitrate accumulation was the result of high N-level combined with low light intensity and high temperature.

MAYNARD—BARKER (1974) and CANTLIFFE (1972b) indicated that the climatic factor of temperature acted in such a way that the NO_3-N in plant tissues was decreased by low temperature without decreasing the non-nitrate fraction. KRETSCHMER (1958) and YOUNIS *et al.* (1965) mentioned that nitrate reductase activity sharply decreased with increasing air temperature from 15°C to 20 or 25°C, i.e. that nitrate accumulation was associated with an increase in temperature. Particularly high temperatures ($>30^\circ C$) decreased the activity of nitrate reductase enzyme in corn (KRETSCHMER 1958). MINOTTI—STANKEY (1973), in trials on beet, indicated that NO_3-N concentration in the whole plant was affected by the diurnal fluctuations in air and soil temperature and that nitrate concentration reached a maximum in the early morning from 4 to 8 a.m., and then decreased after sunrise due to the rising air and soil temperature, as well as the increasing rate of photosynthesis, reaching a minimum after midday at 4 p.m. CANTLIFFE (1972b) carried out trials on spinach grown in a thermo-controlled growth chamber at 5, 10, 15, 20, 25 or 30°C for 28 days, starting with one month old spinach plants growing in pots of sandy loam soil. In general, the NO_3 concentration

increased with increasing temperature within 3 N-levels (0, 50 or 200 mg N/kg of soil). There was a significant interaction between temperature and N-doses. For instance, at zero nitrogen, nitrate did not begin to accumulate until the temperature rose above 15°C, while at 50 and 200 mg N/kg soil nitrate accumulation began at 10 and 5°C, respectively. The experiments of HAGEMAN—FLESHER (1960) showed that nitrate reductase enzyme, which is responsible for the first step of NO_3 assimilation, loses activity rapidly in the dark.

People are continuously exposed to nitrate and nitrite through drugs, drinking water and foods. Fresh and processed vegetables are often considerable sources of nitrate intake. Therefore, it is very important to study the nitrate accumulation in vegetables and factors influencing its occurrence especially in edible parts used for human consumption. The results reported by BURDEN (1961) indicated that nitrate toxicity is relatively lower than nitrite and that the fatal dose in humans is about 15–70 mg $\text{NO}_3\text{—N}$ and 20 mg $\text{NO}_2\text{—N}$ per every kilogram of the adult body weight. Nitrate may be converted to nitrite during the storage of vegetable products as a result of bacterial action or plant NR activity. If the NO_2 ion is absorbed into the blood, the Fe^{++} of haemoglobin may be oxidized to Fe^{+++} , producing methaemoglobin which cannot transport oxygen. Babies are more susceptible to methaemoglobinaemia than older children or adults (LUHRS 1973).

Pot experiments took place under greenhouse conditions in the early summer seasons of 1976 and 1977 at the Experimental Farm of the University of Horticulture at Soroksár, near Budapest. In 1976 three nitrogen levels (10, 20 and 30 mg N/100 g sandy soil) and 4 N-forms (NO_3 , NH_4^+ , NH_4NO_3 and urea) were applied as nutrient solution to the creamy white waxy sweet pepper cv. "Soroksári hajtató". The N-sources were $(\text{NH}_4)_2\text{SO}_4$, $\text{Ca}(\text{NO}_3)_2 \cdot 4\text{H}_2\text{O}$, NH_4NO_3 and $\text{CO}(\text{NH}_2)_2$.

In 1977 two different growth chambers, with day temperatures of $18 \pm 3^\circ\text{C}$ and $25 \pm 3^\circ\text{C}$, and three N-forms (NO_3 , NH_4^+ and urea) plus the control were investigated. The

Table 1

Effect of N-treatments (levels and forms) on total-N, $\text{NO}_3\text{—N}$ concentration (mg/g dry wt) and percentage of $\text{NO}_3\text{—N}$ /total-N in vegetative tops and mature fruits of cv. Soroksári Hajtató

Soroksár, 1976

N-treatments, mg N/100 g soil	Tops at flowering stage				Mature fruits			
	dry matter, %	$\text{NO}_3\text{—N}$, mg/g	Total-N, mg/g	$\text{NO}_3\text{—N}$ total-N, %	dry matter, %	$\text{NO}_3\text{—N}$, mg/g	Total-N, mg/g	$\text{NO}_3\text{—N}$ total-N, %
10 mg N— NO_3	12.61	0.893	25.64	3.48	5.87	0.100	23.07	0.43
10 mg N— NH_4	13.13	0.954	24.99	3.82	6.08	0.108	25.57	0.42
10 mg N— NH_4NO_3	12.70	0.296	20.37	1.45	5.42	0.096	24.87	0.39
10 mg N-Urea	12.18	1.639	28.76	5.70	4.96	—	23.87	—
20 mg N— NO_3	11.57	7.668	40.61	18.88	7.39	0.240	26.35	0.91
20 mg N— NH_4	11.16	6.139	41.86	14.67	6.40	0.094	23.91	0.39
20 mg N— NH_4NO_3	11.88	6.126	39.11	15.66	6.93	0.135	25.06	0.54
20 mg N-Urea	12.60	0.439	23.42	1.87	7.14	—	29.45	—
30 mg N— NO_3	11.92	7.715	43.91	17.57	6.96	0.359	28.93	1.24
30 mg N— NH_4	11.21	7.037	49.23	14.30	6.42	0.241	30.05	0.80
30 mg N— NH_4NO_3	10.84	12.748	45.14	28.24	6.99	0.256	27.71	0.92
30 mg N-Urea	12.69	1.232	34.79	3.54	5.95	—	27.84	—
LSD 5%	0.81	1.704	4.855	—		N.S.	1.598	—
LSD 1%	1.09	2.276	6.484	—		N.S.	2.135	—

Table 2

The main effect of N-levels and forms on total-N, NO₃-N accumulation (mg/g dry wt) and the ratio of NO₃-N/total-N in vegetative tops and fruits of cv. Soroksári hajtató

Soroksár, 1976

N-treatments	Tops at flowering stage			Mature fruits		
	NO ₃ -N, mg/g	Total-N, mg/g	NO ₃ -N total-N, %	NO ₃ -N, mg/g	Total-N, mg/g	NO ₃ -N total-N, %
<i>N-levels</i>						
mg N/100 g soil						
10 mg N	0.946	24.94	3.61	0.101	24.25	0.41
20 mg N	5.093	36.25	12.77	0.156	26.19	0.61
30 mg N	7.183	43.27	15.91	0.285	28.63	0.99
LSD 5%	1.258	2.40		0.034	0.725	
LSD 1%	1.789	3.41		0.049	1.031	
<i>N-Form</i>						
NO ₃ -N	5.425	36.72	13.31	0.233	26.12	0.86
NH ₄ -N	4.710	38.69	10.93	0.148	26.51	0.54
NH ₄ NO ₃ -N	6.390	34.87	15.12	0.162	25.05	0.61
Urea-N	1.103	28.99	3.70	—	27.05	
LSD 5%	0.984	2.803		0.077	0.923	
LSD 1%	1.314	2.744		N.S.	N.S.	

N-level was adjusted to 20 mg N/100 g sandy soil for each nitrogen form separately, and the control received no nitrogen application. During the two years of this work, experiments were designed as a split-plot with 6 replications in 1976 and 8 replications in 1977. Two sweet pepper varieties were studied in 1977, namely Soroksári hajtató and Paradicsom alakú zöldség, and the N-sources were (NH₄)₂SO₄, Ca(NO₃)₂ · 4 H₂O and CO(NH₂)₂.

Seedlings with only one pair of untrue leaves (25 days stage) were transplanted on February 23rd into plastic pots with a volume of 5 l, containing 8 kg of sandy soil. The pots were connected and irrigated automatically with a closed irrigation system as mentioned by GABAL (1979). In 1977 the pots were replaced by polyethylene containers and every treatment was included in a flat plastic container, i.e. also under a closed nutrition and irrigation system with no drainage. An analysis of the sandy soil after growing showed: 10 mg total-N, 0.5 mg NO₃-N, 0.1 mg NH₄-N, 10.5 mg P₂O₅ and 4 mg K₂O per 100 g sandy soil, 0.05% humus, 4.5% CaCO₃ and a pH value of 7.2.

According to the system of N-application a nutrient solution including NPK, Mg and microelements was added on 4 occasions; 40% of the whole N-fertilizer was applied at transplanting time and 20% in three equal applications every 21 days. P, K and Mg were added as KH₂PO₄, K₂SO₄ and MgSO₄ · 7 H₂O at doses of 20 mg P₂O₅, 20 mg K₂O and 3 mg Mg per 100 g of sandy soil for all treatments. Microelements: Fe, Zn, Cu and Mn were added as sulphates at doses of 0.06, 0.02, 0.02, 0.05 mg element per 100 g soil, respectively. Boron was added as borax and Mo as sodium tetratungstate at doses of 0.03 mg B and 0.02 mg Mo per 100 g soil.

The vegetative parts (leaves and/or stems) were removed at the flowering stage, dried, finely ground and taken for NO₃-N and total-N analysis. Fruits of the first and second pickings were examined for NO₃-N and total-N.

Total-N was determined according to the modified micro-Kjeldahl method (A.O.A.C.

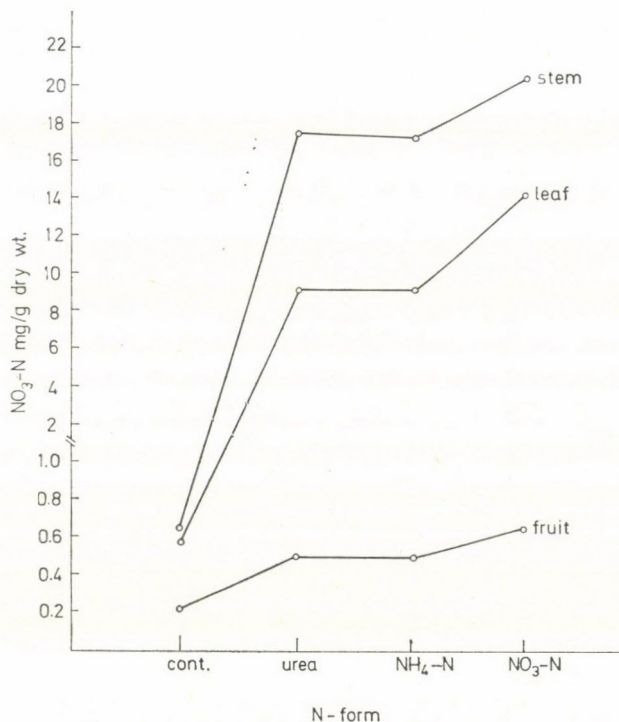


Fig. 1. NO₃-N accumulation in leaves, stems (at flowering time) and fruits of sweet pepper cv. "Soroksári hajtató" as affected by N-form, 1977

1945), and nitrates were determined according to the selective electrode method* of PAUL—CARLSON (1968).

Effect of plant organ. The data illustrated in Tables 1 and 2 and in Fig. 1 show that nitrate accumulated at different concentrations in sweet pepper plant organs, being high in the stems, medium in the leaves and low in the fruits of the cv. "Soroksári hajtató". The values were 12.41–18.85, 6.12–9.99 and 0.36–0.60 mg NO₃-N/g dry matter for each plant organ, respectively. This variance in NO₃-N concentration in plant organs was mainly associated with the growth chamber temperature and the variety. The data of NO₃-N concentration in fruits agree with the results of SPLITTSTOESSER—VANDEMARK (1974) and MAYNARD *et al.* (1976).

Generally, the rate of nitrate absorption from the sandy soil was higher than the rate of NO₃ reduction and assimilation in sweet pepper plant tissues, which resulted in an excess of nitrates accumulating in the leaves and stems, as well as in the fruits. Stems are responsible for NO₃-translocation and this explains the high accumulation of NO₃-N in the stems. In particular, the activity of nitrate reductase enzyme is relatively lower in the stems than in the leaves (MAYNARD *et al.* 1976). This also explains the high ratio of NO₃-N/total-N in stems compared with leaves and fruits. This ratio was 4.60–6.31, 1.41–2.19 and 0.013–0.021 for each organ, respectively. On the other hand, the high content of NO₃-N in stems means that the rate of nitrogen absorption from the soil was higher than the rate of translocation and the rate of nitrate reduction and assimilation.

* The author wishes to register his great thanks to Prof. Dr. H. J. Daunicht, Head of Vegetable Institute, Technical University, West Berlin, Dahlem for the facilities offered during this work.

The data from plant organ analysis indicated that leaves accumulated $\text{NO}_3\text{-N}$ 17 to 63 times more than fruits, and stems contained about 1.68–2 times as much $\text{NO}_3\text{-N}$ as leaves, while the total-N% was higher in leaves than in stems or fruits. This result agrees with KRETSCHMER (1958). The whole vegetative analysis shown in Table 1 indicated that aerial parts of sweet pepper accumulated about 24 times as much $\text{NO}_3\text{-N}$ as fruits.

Effect of day temperature in the growth chamber. Growing sweet pepper varieties under a temperature of $25 \pm 3^\circ\text{C}$ significantly increased the $\text{NO}_3\text{-N}$ accumulation in plant tissues (leaves, stems and fruits) compared with plants grown at $18 \pm 3^\circ\text{C}$, as illustrated by the data in Tables 3 and 4 and by Figs 2 and 3. The fruits of both varieties produced at the high temperature accumulated 1.61 times as much $\text{NO}_3\text{-N}$ and higher total-N compared with fruits produced under the low temperature, as shown in Fig. 2. At the low temperature, $\text{NO}_3\text{-N}$ represented about 43–46% of the stem total-N, while this increased to 63–71% at the high temperature, but the total-N content of the stems was not significantly affected by temperature (Table 6). The higher accumulation of nitrates in leaf, stem and fruit was correlated with the high day temperature. This result was previously mentioned by KRETSCHMER (1958), YOUNIS *et al.* (1965) and MAYNARD *et al.* (1976) and it is explained by the reduction of NR activity under high temperature conditions.

The high rate of nitrification under conditions of high temperature ($25 \pm 3^\circ\text{C}$) led to high available $\text{NO}_3\text{-N}$ in the soil. This may explain the high $\text{NO}_3\text{-N}$ uptake and consequently the high $\text{NO}_3\text{-N}$ accumulation in sweet pepper plants grown in hot chambers ($25 \pm 3^\circ\text{C}$) compared to that in plants from cold chambers ($18 \pm 3^\circ\text{C}$) (Fig. 3). The hot chamber conditions in the 1977 experiment were $25 \pm 3^\circ\text{C}$, i.e. high enough to decrease the activity of nitrate reductase enzyme, which is greatly decreased at temperatures of 20–25 and 30°C or above (KRETSCHMER 1958 and YOUNIS *et al.* 1965). On the other hand, the day temperature in the cold chamber was $18 \pm 3^\circ\text{C}$, i.e. somewhat too high to decrease $\text{NO}_3\text{-N}$ uptake, which is considerably depressed at 12.7°C or below, as mentioned by MAYNARD *et al.* (1976). This of course

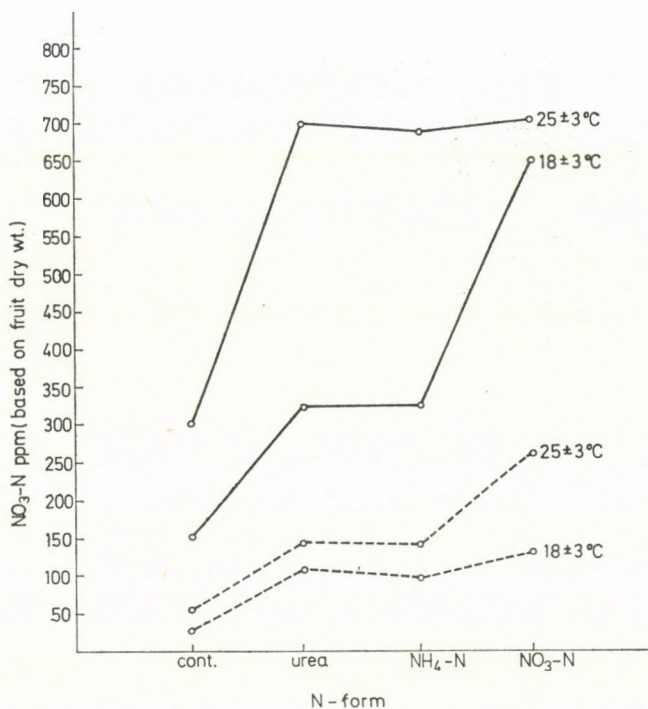


Fig. 2. $\text{NO}_3\text{-N}$ accumulation in creamy white waxy mature fruits of cv. "Soroksári hajtató" (—) and red ripe fruits of cv. "Paradicsom alakú zöld" (----) as affected by N-form and day temperature, 1977

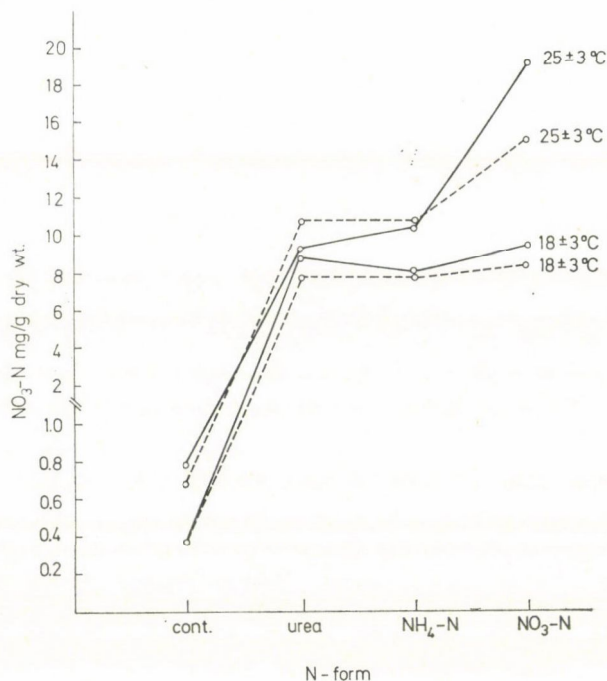


Fig. 3. NO₃-N accumulation in leaves of the two varieties "Soroksári hajtató" (—) and "Paradicsom alakú zöld" (-----) as affected by day temperature and N-form, 1977

does not mean that NO₃-assimilation rates were unaffected by temperature, but simply that the effects on the uptake were relatively greater.

Effect of doses of N-application. Data obtained in 1977 (Tables 5 and 6) showed that plants receiving N-fertilizer as NO₃, NH₄ or Urea-N (20 mg N/100 g soil) contained more NO₃-N in leaf, stem and fruit tissues than the control plants (with no N-application), as shown in Fig. 1. Also, the data obtained in 1976 (Table 2) showed that NO₃-N accumulation in vegetative tops was increased from 0.946 to 5.093 or 7.183 mg NO₃-N/g by increasing the level of N-application from 10 to 20 or 30 mg N/100 g soil, respectively. The data of nitrate accumulation in fruits (Table 2) indicated the same trend. This positive correlation between N-doses and NO₃-N accumulation in sweet pepper tissues is in accordance with the results of MAYNARD-BARKER (1974) on lettuce, and CANTLIFFE (1972a, b and 1973) on spinach and beet.

The application of 30 mg N/100 g soil gave the highest nitrate concentration in fruits, which reached 0.285 mg NO₃-N/g dry weight (Table 2). However, this concentration is tolerated for human consumption according to the results of FRITZ-VENTER (1978), who determined the maximum NO₃-N concentration in kohlrabi as 250 ppm NO₃ in the fresh stem. N-deficiency in the control plants led to a great decrease in total-N as well as NO₃-N in all plant organs compared with plants receiving 20 mg N/100 g soil.

Effect of the variety. Data of NO₃-N accumulation in leaves (Table 3) showed no considerable differences due to the varieties. Stems of the variety "Paradicsom alakú zöld" only seem to accumulate a large quantity of nitrates at high temperature, reaching 18.850 mg NO₃-N/g compared with the variety "Soroksári hajtató", which contained 15.218 mg NO₃-N/g based on the dry weight of the stems (Tables 5 and 6). Fruits of the cv. "Soroksári hajtató" accumulated 4 times as much NO₃-N as the fruits of the variety "Paradicsom alakú zöld". This great variance in fruit NO₃-N could be explained by the two different physiological stages of the fruits at picking time. The cv. "Soroksári hajtató" is harvested at the mature stage when the fruits have a creamy white glassy colour but the cv. "Paradicsom alakú zöld" is harvested at the ripening stage when the fruits have a dark red colour. The results of HOFF-WILCOX (1970) showed that the NO₃-N concentration in unripe tomato fruit was higher than in ripe fruits.

Table 3

Nitrate accumulation (mg NO₃-N/g dry wt) in leaf, stem and fruit of the two varieties as affected by day temperature and N-form, 1977

Treatments	cv. Paradiesom alakú zöldség			cv. Soroksári hajtató		
	leaf	stem	fruit	leaf	stem	fruit
<i>Day-temperature</i>						
(low) 18 ± 3 °C	8.03	16.45	0.113	8.85	17.04	0.432
(high) 25 ± 3 °C	12.22	24.42	0.182	13.07	20.04	0.698
LSD 5%	2.28	3.72	0.004	2.56	1.79	0.262
<i>N-form</i>						
NO ₃ -N	11.75	20.72	0.198	14.35	20.50	0.677
NH ₄ -N	9.31	20.89	0.118	9.31	17.48	0.507
Urea-N	9.31	19.69	0.127	9.21	17.64	0.511
LSD 5%	2.36	1.43	0.010	1.99	3.40	0.129

Table 4

Total-N content (mg N/g dry wt) in leaf, stem and fruit of the two varieties as affected by day temperature and N-form, 1977

Treatments	cv. Paradiesom alakú zöldség			cv. Soroksári hajtató		
	leaf	stem	fruit	leaf	stem	fruit
<i>Day temperature</i>						
(low) 18 ± 3 °C	47.38	29.41	23.92	48.89	28.69	26.44
(high) 25 ± 3 °C	50.89	27.36	26.87	47.78	24.54	28.75
LSD 5%	2.12	N.S.	1.80	N.S.	N.S.	1.76
<i>N-form</i>						
NO ₃ -N	46.96	26.04	26.53	44.79	25.68	29.34
NH ₄ -N	49.94	27.79	23.75	48.79	27.20	27.16
Urea-N	50.53	31.33	25.90	51.44	26.97	26.29
LSD 5%	3.19	2.56	2.19	3.028	1.73	2.16

Effect of N-form. Regardless of day temperature, plants of the two varieties accumulated significantly more nitrates in leaves and fruits when fertilized with Ca(NO₃)₂ than when fertilized with ammonium sulphate or urea, or in the control plants which received no nitrogen (Table 3). However, the quantity of NO₃-N in stems did not vary according to N-form. This means that the rate of NO₃ absorption (from the soil) and translocation (through the stem) to leaves and fruits was higher in plants fertilized with NO₃-N compared to other N-forms.

At low temperature, plants of cv. "Soroksári hajtató" fertilized with NO₃-N accumulated about twice as much nitrate in the fruits compared to those fertilized with NH₄-N or urea. On the other hand, at high temperature (25 ± 3°C), neither total-N nor NO₃-N of the fruits was affected by N-form. This may be explained by the high rate of urea and (NH₄)₂SO₄

Table 5

Total nitrogen and nitrate-N (mg/g dry wt) concentration in leaf, stem and fruit of sweet pepper cv. Soroksári hajtató as affected by N-form and day temperature in greenhouse chambers

Soroksár, 1977

N-treat-ments*	Leaf (blade + petiole)				Stem				Fruit			
	dry matter %	NO ₃ -N mg/g	Total-N mg/g	$\frac{\text{NO}_3\text{-N}}{\text{Total-N}}$ %	dry matter %	NO ₃ -N mg/g	Total-N mg/g	$\frac{\text{NO}_3\text{-N}}{\text{Total-N}}$ %	dry matter %	NO ₃ -N mg/g	Total-N mg/g	$\frac{\text{NO}_3\text{-N}}{\text{Total-N}}$ %
Day temperature 18 ± 3°C												
1. NO ₃ -N	14.62	9.51	43.93	21.65	12.82	17.01	25.73	66.09	7.51	0.648	29.40	2.20
2. NH ₄ -N	13.48	8.07	50.13	16.09	12.03	16.75	30.70	54.55	7.03	0.325	26.08	1.25
3. Urea-N	13.72	8.96	52.62	17.03	11.59	17.36	29.65	58.54	7.31	0.332	23.85	1.35
4. Control	13.00	0.38	19.40	1.98	11.34	0.59	12.00	4.94	7.66	0.152	26.75	0.57
Mean	13.94	8.85	48.89	18.26	12.15	17.04	28.69	59.73	7.28	0.435	26.44	1.60
Day temperature 25 ± 3°C												
5. NO ₃ -N	14.10	19.19	45.65	42.05	12.48	23.99	25.63	93.60	7.63	0.706	29.28	2.41
6. NH ₄ -N	11.92	10.56	47.45	22.25	11.01	18.21	23.70	76.82	7.48	0.689	28.25	2.44
7. Urea-N	12.40	9.46	50.25	18.82	12.46	17.92	24.28	73.82	7.96	0.699	28.73	2.45
8. Control	13.43	0.79	17.25	4.58	13.01	0.74	8.85	8.38	7.05	0.301	27.00	1.11
Mean 5-7	12.81	13.07	47.78	27.71	11.98	20.04	24.54	81.41	7.69	0.698	28.75	2.43
LSD 5%	0.86	3.65	4.28	—	0.80	4.81	2.45	—	N.S.	0.183	3.05	—

* All nitrogen forms were added as 20 mg N/100 g soil. The control received all micro- and macroelements except nitrogen.

Table 6

Total nitrogen and nitrate-N (mg/g dry wt) accumulation in leaf, stem and fruit of sweet pepper cv. Paradicsom alakú zöld as affected by nitrogen form and day-temperature in greenhouse chambers

Soroksár, 1977

Treatments	Leaf (blade + petiole)				Stem				Fruit			
	dry matter %	NO ₃ -N mg/g	Total-N mg/g	NO ₃ -N / Total-N %	dry matter %	NO ₃ -N mg/g	Total-N mg/g	NO ₃ -N / Total-N %	dry matter %	NO ₃ -N mg/g	Total-N mg/g	NO ₃ -N / Total-N %
<i>Day temperature 18 ± 3°C</i>												
1. NO ₃ -N	15.24	8.40	44.48	19.54	12.77	17.31	27.03	64.04	9.69	0.132	26.25	0.50
2. NH ₄ -N	14.10	7.86	48.98	16.05	12.62	16.94	29.43	57.56	11.38	0.097	22.20	0.44
3. Urea-N	14.92	7.83	48.70	16.07	12.12	15.10	31.78	47.51	10.10	0.110	23.30	0.47
4. Control	13.70	0.39	18.30	2.16	12.87	0.29	11.10	2.61	6.39	0.028	19.70	0.14
Mean 1—3	14.75	8.03	47.39	17.22	12.50	16.45	29.41	56.37	10.39	0.113	23.92	0.47
<i>Day temperature 25 ± 3°C</i>												
5. NO ₃ -N	14.62	15.10	49.43	30.55	13.48	24.13	25.05	96.33	11.08	0.263	26.80	0.98
6. NH ₄ -N	13.25	10.75	50.90	21.12	12.45	24.84	26.15	94.99	10.00	0.139	25.30	0.55
7. Urea-N	13.80	10.80	52.35	20.63	12.28	24.27	30.88	78.59	11.09	0.144	28.50	0.51
8. Control	10.45	0.69	18.90	3.64	11.79	1.34	10.40	12.88	6.12	0.056	20.60	0.27
Mean 5—7	13.89	12.22	50.89	24.10	12.74	24.41	27.36	89.97	10.72	0.182	26.87	0.68
LSD 5%		3.33	4.52	—		2.02	3.62	—		0.015	3.10	—

nitrification under high temperature conditions. In the variety "Paradicsom alakú zöld" the same trend was recorded and ripe fruits contained 0.198, 0.118, 0.127 and 0.042 mg $\text{NO}_3\text{-N/g}$ dry matter, when the plants were fertilized with $\text{NO}_3\text{-N}$, $\text{NH}_4\text{-N}$, urea or control, respectively. The data are illustrated in Table 3.

The data in Table 4 show that the total-N concentration in the leaves was relatively decreased when $\text{Ca}(\text{NO}_3)_2$ was applied compared to urea and $\text{NH}_4\text{-N}$ sources. However, the total-N of the fruits increased in plants which received $\text{NO}_3\text{-N}$ compared with other nitrogen forms.

Ratio of $\text{NO}_3\text{-N}/\text{total-N}$. The data in Table 2 show that the ratio of $\text{NO}_3\text{-N}/\text{total-N}$ was increased in the foliage and fruits by increasing the level of N-application. From Tables 5 and 6 it can be seen that the ratio of $\text{NO}_3\text{-N}/\text{total-N}$ was greatly affected by the N-form and the plant organ. In cv. "Soroksári hajtató" the ratio $\text{NO}_3\text{-N}/\text{total-N}$ was highest in the stem (60–81%), medium in the leaves (18–28%) and low in the fruit (1.6–2.4%). The same trend was registered in cv. "Paradicsom alakú zöld". In both varieties within 3 plant organs (leaf, stem and fruit) the ratio of $\text{NO}_3\text{-N}/\text{total-N}$ was higher in plants fertilized with $(\text{NH}_4)_2\text{SO}_4$ or urea and very low in the control plants, when no nitrogen was added. Plants which received $\text{Ca}(\text{NO}_3)_2$ showed the highest ratio of $\text{NO}_3\text{-N}/\text{total-N}$ compared to other forms or to the control plants, especially at high levels of N-application (20–30 mg N/100 g soil).

The results indicated that high temperature and $\text{NO}_3\text{-N}$ application increased the rate of nitrification and thereby the nitrate concentration in the soil, which led to a high rate of nitrate uptake by the plants and consequently high $\text{NO}_3\text{-N}$ accumulation in the plant tissues. Nitrate accumulation was high in the stems, medium in the leaves, low in mature fruits and very low in ripe fruits of sweet peppers.

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STIMULATIVE EFFECT OF HEAT TREATMENT ON GERMINATIVE ABILITY IN ANNUAL MEDICAGO SPECIES

Until the turn of the century the annual *Medicago* species were mostly studied from a botanical point of view. In recent decades their agronomical importance has also increased, particularly in dry regions (e.g. Southern Australia, the zone running parallel to the north-western coast of Egypt). Hungary also has a collection of these species (at Tápíószele), and they are studied in depth in Canada (LESINS *et al.* 1976). In Hungary, BÓCSA—MÁNDY (1964) gave an account of resistance breeding studies carried out on these species.

Nowadays it is worth examining annual *Medicago* species for agronomical characters which may be important in breeding. This is the objective of the investigations carried out at Tápíószele on annual *Medicago* species.

Annual *Medicago* species are characterized by a high degree of hard-coatedness, which greatly reduces their economic value in dry regions; it may therefore be difficult to provide the right stand density. The germination of hard-coated seeds is unreliable even in places where the ground-water level is satisfactory, since the seed-coat itself forms an impermeable layer. The subject is therefore of great importance in Egypt. The investigations were aimed at exercising a favourable effect on the germinative ability through dilation caused by heat treatment.

Many researchers have tried to improve the germinative ability in order to ensure the required plant stand in the field. On the basis of investigations on Central and Western Australian grasslands SCOTT—BROWNLEE (1970) found a wide fluctuation in temperature to have a favourable effect on the dehiscence of the seed-coat. LESINS *et al.* (1976) found that *M. minima* (L.) Bart pretreated at 55°C gave 88% germination after seven days; the remaining 12% also had rootlets but these did not reach a length of 1 cm. The authors pointed out that it may be of interest to *Medicago* researchers that high temperatures may have a more general application for conditioning annual *Medicago* seeds for germination. A long after-ripening of seeds is common in *M. disciformis*, *M. orbicularis*, *M. littoralis*, *M. sawagi* and *M. minima*, among others.

The possibility of breeding annual *Medicago* species has been mentioned by Hungarian authors as well (BÓCSA—MÁNDY 1964). The authors emphasize the higher resistance of these species. There can be no doubt that the incorporation of characteristics from wild species in cultivated ones also depends on whether the former can be crossed.

Annual *Medicago* species have been studied by other authors as well, e.g. GROSSHEIM (1945) in Komarov, CLEMENT (1962) and HEYN (1963).

The present investigations covered 15 annual *Medicago* species. The species examined were obtained from Canada (University of Alberta, Department of Genetics), Australia (Department of Agriculture and Fisheries), and from the collection of the Agrobotanical Research Centre of the National Institute for Agricultural Variety Testing. Particular attention was paid to cultivars. The species studied were taxonomically identified. The seeds of plants thus identified were sown in the greenhouse and examined in two groups:

A) without storage

B) stored for one year at room temperature. Both groups were given the following heat treatments:

- I. untreated seed (control)
- II. pretreatment at +5°C for 24 hours
- III. pretreatment at 50°C for 15 days
- IV. pretreatment at 55°C for 10 days
- V. pretreatment at 60°C for 5 days

Seed thus treated were sown in four replications in pots (53 × 34 cm) filled with clayey sand, with 100 seed in each.

The germination percentage was checked every day. The plants were subsequently removed from the pots and transplanted, so as to increase the reliability. The trials were performed at Tápiószéle in 1976 and 1977.

In the tables and figures L stands for Lesins, A for seeds of our own collection, P for a material of polymorphous type and NA for newly obtained seed.

The species studied and the results of seed treatments without storage are shown in Table 1. Most of the examined species originated from the major regions where annual *Medicago* species are grown, occur or are investigated. The Canadian species were placed at our disposal by Lesins and the Southern Australian ones by Mattson, to whom grateful thanks are expressed for their kind assistance. Two of the examined species originate from Europe, and another from the collection of the National Institute for Agricultural Variety Testing (Agrobotanical Research Centre, Tápiószéle).

Germinating power of unstored seeds. Table 1 shows the germination percentage of unstored seeds 10 days after germination, in the control and the four different heat treatments.

The data in the table reveal in the first place a considerable difference in germination percentage between treated and untreated seeds. The 3–15% germination of the untreated seeds was exceeded even by the 24-hour treatment at 5°C, while heat treatments at 50–60°C for 5, 10 and 15 days, respectively, resulted in an average of more than 50% germination ($\bar{X} = 57.5; 77.3; 77.6$), with only a few species (e.g. *M. intertexta*, *M. rotata*) falling behind. Over an average of 15 species the best result was obtained with 10 days of treatment at 55°C. Differences between the species in favour of the latter treatment were conspicuous: many species gave favourable responses to the 10-day treatment at 55°C. The experimental results are also shown in Fig. 1, where the differences between species and treatments are clearly seen.

Table 1

Percentage germination of annual *Medicago* species given heat treatment without storage

(Tápiószéle, 1976)

Serial number	Designation	Species, variety	I	II	III	IV	V
			Un-treated	Heat treatment			
				5°C 24 hours	50°C 15 days	55°C 10 days	60°C 5 days
1.	L-1	<i>M. aculesta</i> var. <i>aculesta</i>	2	15	50	60	63
2.	A-3	<i>M. blanchiana</i> Boiss var. <i>Bonoratiana</i>	3	20	50	70	76
3.	L-9	<i>M. intertexta</i> var. <i>echinus</i>	0	10	29	41	42
4.	L-5	<i>M. intertexta</i> var. <i>ciliaris</i>	0	5	39	60	60
5.	L-11	<i>M. littoralis</i> Rhode var. <i>littoralis</i>	10	12	70	80	75
6.	NA-7	<i>M. littoralis</i> Rhode cv. Harbinger	15	20	87	95	96
7.	A-11	<i>M. lupulina</i> L.	0	20	40	70	78
8.	A-5	<i>M. orbicularis</i> (L.) Bart	10	15	69	80	80
9.	P-2	<i>M. polymorpha</i> var. <i>polymorpha</i>	3	17	60	85	80
10.	P-3	<i>M. polymorpha</i> var. <i>vulgaris</i>	4	20	63	87	79
11.	A-6	<i>M. rigidula</i> Desr. var. <i>agrestis</i>	6	15	60	80	90
12.	L-16	<i>M. rotata</i> Boiss var. <i>rotata</i>	0	10	15	60	70
13.	L-17	<i>M. striata</i> Bast.	9	12	75	97	95
14.	NA-8	<i>M. tornata</i> Mill. cv. Tornafeld	14	20	90	100	90
15.	L-18	<i>M. temoreana</i> Ser.	3	17	65	95	100
		Species average	5.3	15.2	57.5	77.3	77.6

Germination of stored seeds after heat treatment. The seeds were stored for 1 year before the heat treatments described above. The results are presented in Table 2 and Fig. 2.

According to the data in the table hard-coatedness was reduced and germinative ability increased by the storage. The germination percentage was 5.3 for the unstored and 18.0 for the stored seeds over an average of 15 species, the values for stored seeds ranging between 3 and 45%, i.e. the differences between the species increased. The germinating vigour

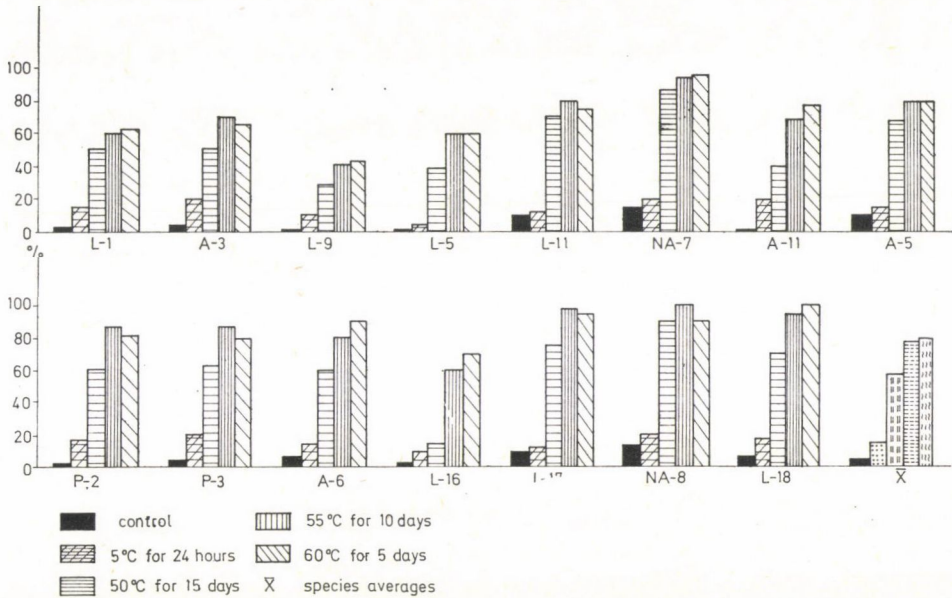


Fig. 1. Effects of various heat treatments on germination of seeds of annual *Medicago* species treated without storage (Tápiószele, 1976)

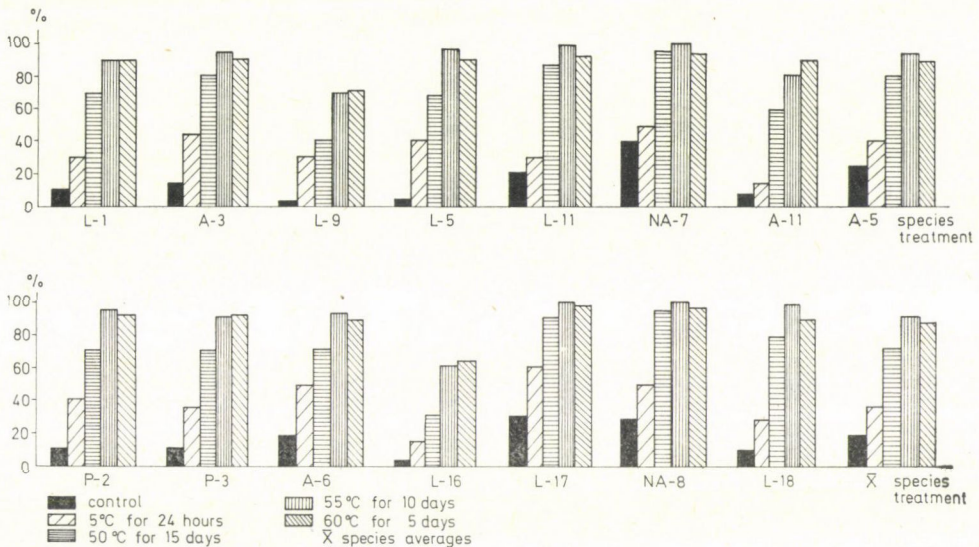


Fig. 2. Effects of various heat treatments on germination of stored seeds of annual *Medicago* species (Tápiószele, 1977)

Table 2

Percentage germination of annual *Medicago* species stored for 1 year
and treated at different temperatures

(Tápiószele, 1977)

Serial number	Designation	Species, variety	I	II	III	IV	V
			Un-treated	Heat treatment			
				5°C 24 hours	50°C 15 days	55°C 10 days	60°C 5 days
1.	L-1	<i>M. aculeata</i> var. <i>aculeata</i>	10	30	70	90	90
2.	A-3	<i>M. blanchena</i> Boiss var. <i>Bonoratiana</i>	14	44	80	95	91
3.	L-9	<i>M. intertexta</i> var. <i>echinus</i>	3	30	40	70	71
4.	L-5	<i>M. intertexta</i> var. <i>ciliaris</i>	45	40	68	96	90
5.	L-11	<i>M. littoralis</i> Rhode var. <i>littoralis</i>	21	30	87	99	93
6.	NA-7	<i>M. littoralis</i> Rhode cv. Harbinger	40	49	95	100	95
7.	A-11	<i>M. lupulina</i> L.	4	15	60	80	90
8.	A-5	<i>M. orbicularis</i> (L.) Bart	25	40	80	95	90
9.	P-2	<i>M. polymorpha</i> var. <i>polymorpha</i>	10	40	70	95	93
10.	P-3	<i>M. polymorpha</i> var. <i>vulgaris</i>	10	35	70	91	92
11.	A-6	<i>M. rigidula</i> Desr. var. <i>agrestis</i>	18	49	71	93	90
12.	L-16	<i>M. rotata</i> Boiss var. <i>rotata</i>	3	15	30	60	64
13.	L-17	<i>M. striata</i> Bast.	30	60	91	100	99
14.	NA-8	<i>M. tornata</i> Mill. cv. Tornafield	29	50	95	100	97
15.	L-18	<i>M. tenoerana</i> Ser.	9	28	79	98	90
		\bar{x}	18.0	37.0	72.4	90.8	89.0

shown by the species *M. intertexta* var. *ciliaris* and *M. littoralis* was 40–50% in contrast to 3–4% in *M. intertexta* var. *echinus* and *M. lupulina*.

In stored seeds the treatments resulted in higher average germinating vigour than in those given heat treatments without storage. The average germination percentages obtained with heat treatments were 37.0% after 24 hours at 5°C, 72.4% after 15 days at 50°C, 90.8% after 10 days at 55°C and 89.0% after 5 days at 60°C. The best result in the case of stored seeds was again obtained with 10 days of treatment at 55°C.

Specific differences in germination in annual *Medicago* species. As seen from the tables and figures presented, the species gave different responses to the same treatments.

In the case of stored seeds the absolute difference was 45% in treatment II. The best germination (60%) was observed in *M. striata*, the worst (15%) in *M. lupulina* and *M. rotata*. In treatment III the difference between the species was 65%. The highest germination percentages were shown by the cultivars *M. littoralis* Rhode cv. Harbinger and *M. tornata* cv. Tornafield, while *M. rotata* proved to be the poorest of all (30%). In treatment IV three species reached 100% germination: the two cultivars mentioned above and *M. striata* Bast. *M. rotata* again gave the lowest (60%) germination percentage. The best responses to treatment V were given by *M. striata*, followed by *M. tornata* Mill. cv. Tornafield and *M. littoralis* Rhode cv. Harbinger. The latter showed a comparatively high (93%) germinative ability even in its wild form.

Varietal differences in the case of unstored and stored seeds can also be seen in Figs 1 and 2.

It can be established that the treatments resulted in an intensive rise in germination percentage and a fairly acceptable agronomical level in most species (80–90%). The result suggests an interaction between the treatments and the genotypes of the species.

Effect of storage on the germinative ability of seeds. As seen from Tables 1 and 2, one year of storage has a favourable effect on the germinative ability of annual *Medicago* seeds without any other treatment. Figure 3 shows the effect of storage on the species examined.

As a result of storage without heat treatments the germinative ability of the species *M. intertexta* var. *ciliaris*, *M. littoralis*, *M. striata* and *M. tornata* improved most. It is noteworthy that *M. intertexta*, for example, was practically incapable of germination before storage. On the other hand, in some species storage did not improve the germinative ability (e.g. *M. intertexta* var. *echinus*, *M. lupulina*, *M. rotata* Boiss var. *rotata*). However, most of the species showed considerable improvement. Over an average of 15 species, storage led increased germination, though its effect was significantly exceeded by the effect of each treatment.

Figure 4. shows the totalled results of treatments on stored seeds and of those given heat treatment without storage. It can be seen that as a result of treatment the improvement in

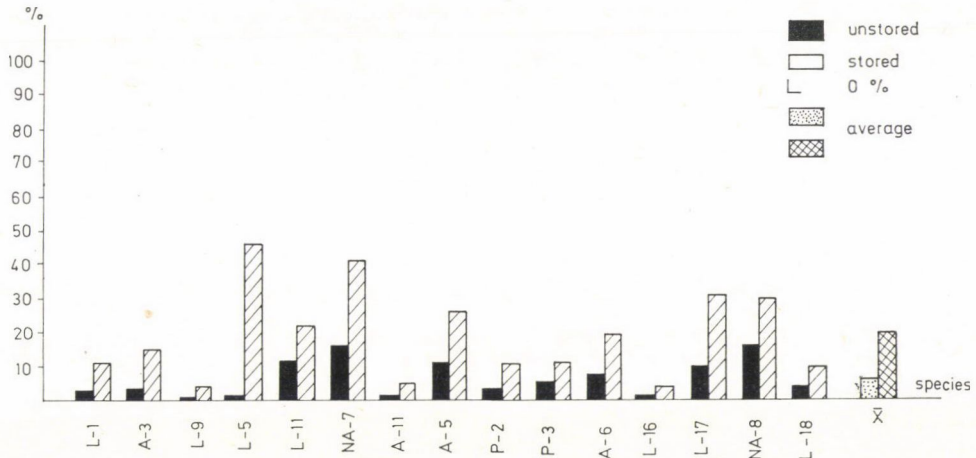


Fig. 3. Germination of stored and unstored seeds of annual *Medicago* species without heat treatment

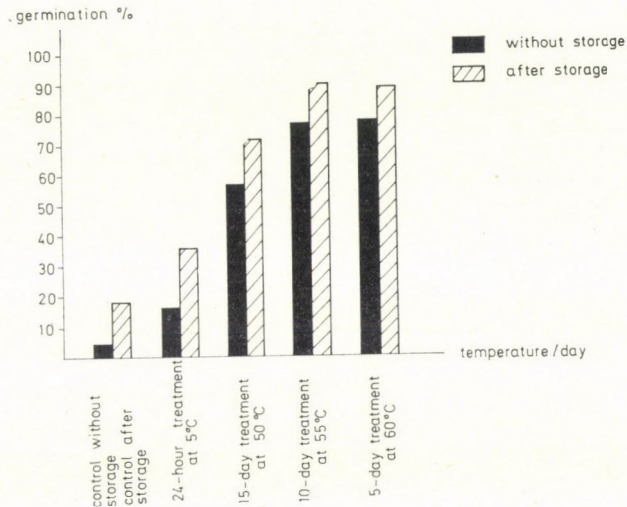


Fig. 4. Effects of storage and various heat treatments on germination in annual *Medicago* species over an average of 15 species

germinative ability showed an increasing tendency, considerably exceeding the germination of the control seeds. The improvement was especially remarkable for a longer period of treatment at higher temperatures (55—60°C). One of the reasons is almost certainly the fact that the experimental conditions were similar to the natural heat effects often existing in the districts where these species are grown. Dilatation promotes the dehiscence of the seed-coat, and this fact encourages us to provide the necessary conditions artificially. The procedure may be suitable for increasing the germinative ability and agronomical value of annual *Medicago* species in all the districts where they are currently grown, or where more extensive cultivation is planned (including Egypt, for instance, where the cultivars of these species could be grown on larger areas). In these areas a large proportion of the species are native plants, and they are likely to be produced to a greater extent in the future. It is the cultivars of these species which are expected to be of primary importance.

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INFLUENCE OF SOIL TYPES, PRE-SOWING SEED TREATMENTS, AVAILABLE AMOUNTS OF SOIL NUTRIENTS AND THEIR COMBINATIONS ON TOMATOES. II. EFFECT ON MINERAL STATUS OF SEEDLINGS AND LEAF PIGMENT CONTENTS

The relationship between the chemical and physical nature of the soil and the nutritional status of seedlings is a complex phenomenon, since the nutritional status and other related features of seedlings, such as pigments, and subsequently their effects on the condition, growth and ability of seedlings to give early, abundant flower anthesis and consequently earlier, larger yields are influenced by several factors which have no bearing on the availability of soil nutrients. The mineral contents of tomato leaves (CANNELL *et al.* 1963, FERENCZ *et al.* 1964, HOWLETT—KRETCHMEN 1969, PROHÁSZKA—HAMAR 1977, SEBULO 1975), and the chlorophyll and carotenoid contents of leaves (LEDOVS'KIL 1972, 1973) were affected by differential application of nitrogen, phosphorus and potassium to plants. Pre-sowing seed treatments also have an effect on nitrogen uptake, compounds and utilization (GAAROW 1968, NIKOLOV 1973).

Since no information is available on the influence of a combination of the above factors the present study was designed to study the relationship between the proportions of essential macro-nutrient elements available in the soil, soil types, pre-sowing seed treatments and their combinations on the one side, and the nutritional status of tomato seedlings and some of their related features such as chlorophyll and carotenoid contents on the other.

Three different factors and all their combinations were tested in a semi-split-plot randomized block design with three replications in a trial carried out on the tomato variety Kecskeméti Jubileum. The main plots were devoted to studying soil types, sand and loamy sand, with different combinations of the amounts and ratios of N, P₂O₅, K₂O in the soil with 2 levels for each, 6—7 and 12—13 mg/100 g dry soil. The different combinations used were as follows:

No. of treatment	Water soluble			N	P ₂ O ₅	K ₂ O
	N	P ₂ O ₅	K ₂ O			
	mg/100 g dry soil					
1	6— 7	6— 7	6— 7	1	1	1
2	6— 7	6— 7	12—13	1	1	2
3	6— 7	12—13	6— 7	1	2	1
4	6— 7	12—13	12—13	1	2	2
5	12—13	6— 7	6— 7	2	1	1
6	12—13	6— 7	12—13	2	1	2
7	12—13	12—13	6— 7	2	2	1
8	12—13	12—13	12—13	2	2	2

Full details of the soil preparation with available nutrients have been reported in a previous paper (EL-SAWAH 1981). The sub-plots were for pre-sowing treatments: dry seeds, seeds soaked for 16 hours in pure water or in 0.4% Volldünger solution, then placed on filter paper to dry and stored ready for use.

Cultural methods. Each soil under study was put in shallow wooden boxes (40×60×10 cm) replicated 3 times and placed on a polyethylene layer to prevent the roots from penetrating into the soil during the experimental period. The seeds for the test were sown 1 cm deep in the boxes. Each box contained 12 rows divided into 3 sets of 4 rows containing 104 seeds for each seed treatment, with 26 seeds in each row. When emergence was completed, the plants were thinned to 13 plants per row. On the 40th day 72 plants/treatment (representing 3 replicates) were sampled and immediately transported to the laboratory for determining the chlorophyll (*a*, *b*, *a/b* and total) and carotenoid contents in the leaves, as well as total nitrogen, phosphorus and potassium uptake per seedling and their percentages in both roots and tops of seedlings on a dry matter basis.

Effect of available nutrient ratios and their quantities in the soil. The data in Table 1 reveal that

1. The total uptake of N, P and K per seedling and also their percentages in both plant tops and roots largely depended on the absolute quantities of available nutrient elements in the soil and on their ratio. A similar conclusion was reached by FERENCZ *et al.* (1964).

2. Increasing the K ratio in the soil decreased not only the uptake of N and P but also their percentages in both the tops and roots of seedlings. Similar results were obtained by CAMPBELL—SWINGLE (1965) and PROHÁSZKA—HAMAR (1977). Increasing the K ratio also had a stimulating effect on the chlorophyll *a*, *b*, *a + b* and carotenoid contents. This was true particularly when the P ratio was maintained at 1, but when it was 2, the increasing K ratio resulted in a decrease in all the pigments. This can partly be explained by the increasing P ratio in the soil resulting in a higher K content in leaf tissues, to the extent of causing a diminishing N content in the leaf in question and consequently in its pigment contents.

3. Irrespective of the available K ratio in the soil, the total uptake of P and K was increased by an increasing N ratio if the P ratio was held constant at 1, but when it changed to 2, the uptake of P and K decreased. Similarly, all pigments were increased irrespective of the K ratio by increasing N, but this increase was only significant when the P ratio was 2. The favourable effect of P here might be attributed to its stimulating effect on nitrogen uptake.

4. Again independent of the K ratio in the soil, the total uptake of N and K were increased by an increase in the P ratio if the N ratio was held at 1, but at a ratio of 2 the N—K uptake decreased. A similar trend was found for pigments whose contents in the plant depended on N uptake.

5. There were alternative positive effects between N and P; thus their percentages in both tops and roots were increased by increasing the ratio of either of them in the soil. Moreover, an increase in the P or N ratio gave no significant effect on K contents either in roots or in plant tops. The same results were obtained by THOMAS—HEILMAN (1964, 1967) on peppers.

6. Regarding the pigment content, the NPK ratios 2 : 2 : 1 and 2 : 2 : 2 were generally superior, though without any significant difference between them, but the ratios 1 : 2 : 2 and 1 : 2 : 1 were generally depressive, again without any significant difference between

Table 1

Effect of nutrient ratios on mineral status and leaf pigment contents

Characters NPK ratio	Mineral uptake, mg/seedling			Mineral contents, %						Pigment contents, mg/l				
				Plant tops			Plant roots			chl. <i>a</i>	chl. <i>b</i>	chl. <i>a + b</i>	chl. <i>a : b</i>	carot- enoids
	N	P	K	N	P	K	N	P	K					
1 : 1 : 1	10.74	3.00	17.07	2.63	0.73	4.07	1.77	0.555	3.56	1.95	0.99	2.94	1.96	0.66
1 : 1 : 2	9.53	2.91	17.77	2.34	0.68	4.15	1.64	0.564	3.87	2.02	1.04	3.06	1.95	0.69
1 : 2 : 1	12.00	3.77	18.99	2.76	0.85	4.19	1.75	0.577	3.52	1.87	0.94	2.81	2.00	0.60
1 : 2 : 2	11.93	3.58	19.89	2.73	0.80	4.37	1.75	0.584	3.85	1.86	0.94	2.80	1.98	0.62
2 : 1 : 1	14.61	3.34	17.22	3.43	0.74	3.76	2.03	0.517	3.54	1.96	1.01	2.98	1.96	0.61
2 : 1 : 2	14.31	3.49	21.36	3.14	0.72	4.40	2.03	0.516	4.03	2.16	1.13	3.29	1.91	0.69
2 : 2 : 1	13.95	3.56	16.77	3.40	0.83	4.00	2.20	0.577	3.72	2.31	1.15	3.46	2.02	0.73
2 : 2 : 2	14.14	3.41	16.54	3.54	0.87	4.24	1.99	0.562	3.78	2.28	1.20	3.49	1.91	0.73
	**	*	n.s.	***	**	*	**	*	n.s.	***	**	***	n.s.	*

them. The correlation study revealed a positive correlation between the N percentage in seedling tops and the chlorophyll *a*, *b*, and *a* + *b* content in the third leaf from the growing tip of the seedling. P and N (for all) = 10% and 8%, respectively, $r = 0.65$, 0.66 and 0.68 for chlorophyll *a*, *b* and *a* + *b* respectively.

Effect of soil types. Table 2 shows that the nutrient uptake behaviour of tomato seedlings as affected by soil types was relatively different from that of their percentage nutrient contents. Thus, the uptake of nutrients by plants grown on sandy soil was higher than that of plants grown on loamy sand. This result might be attributed to the increase of dry matter production in seedlings on sand, or might be due to the beneficial effect of aeration in sandy soils, which may increase the permeability of the roots to water and nutrients (KRAMER 1956), improve the translocation of potassium from roots to tops (STOLZY—LETEY 1964), change the availability of nutrients that occur in the soil in response to aeration and/or result in changes in the metabolic status of the plant. LIU—JN (1963) and TYAGNY RYADNO (1958) reported that after molecular oxygen had been reduced in the soil, nitrate-nitrogen served as an electron acceptor. Nitrate then disappears, and part of the nitrogen is lost in gaseous form. Moreover, seedlings on sand also showed higher phosphorus but lower nitrogen and potassium percentages in both roots and tops than those on loamy sand. The same observation was made by FLOCKER—NIELSEN (1962), who reported that the total nutrient uptake per plant increased as the soil moisture tension decreased (under the present conditions it was loamy sand). When these data were plotted against the percentage of nutrients absorbed, plants grown at high tension seemed to have higher concentrations of nutrients absorbed for each nutrient except phosphorus. A possible explanation of this discrepancy could be summarized as follows:

I. Since phosphate is a highly immobile ion and since sandy soil allows more intense rooting, the more seedling roots there are, the more they are capable of taking up phosphate as a result of intense root-soil contact; subsequently their percentage increased. Our results agreed with those obtained by MURDOCK—SEAY (1954) and WIERSUM (1961, 1962). ATKINSON (1959) also concluded that restricted root growth mainly impaired the uptake of nutrients of low mobility, such as phosphate.

II. The higher temperature of sand compared to loamy sand resulted in an increase in the translocation of phosphorus from roots to tops, in root growth, rate of phosphorus uptake, mineralization of soil organic phosphate and rate of reaction of fertilizer phosphorus with the soil (APPLE—BUTTS 1952, CASE *et al.* 1964, KNOLL *et al.* 1964, POWER *et al.* 1964a, 1964b, BOWEN 1970).

III. Aeration: PEPKOWITZ—SHIVE (1944) found that the absorption of potassium by tomatoes in culture solution was not directly dependent on the potassium ion; being less hydrated and more mobile than phosphorus it came less under the control of respiratory processes. That explained the higher potassium contents in seedlings on loamy sand than on sand under the present conditions. Moreover, the absorption and accumulation of ammonia nitrogen in plants was shown by SHIVE (1941) to be directly associated with oxygen supply, while the opposite case was true of nitrate nitrogen. Since ammonium nitrate was used as a source of nitrogen in this study, it might be expected that the total absorption of nitrogen would be less dependent on good soil aeration than the accumulation of phosphorus. Therefore, seedlings on loamy sand achieved a higher nitrogen content than those on sand. The data in this study substantiated the hypothesis of KIRK (1945) on corn.

Leaf pigment estimates indicated higher chlorophyll and carotenoid contents in the leaves of seedlings grown in loamy sand. This revealed that the leaf nitrogen content was actually higher in those seedlings, as already mentioned. Moreover, the relatively low temperature of loamy sand apparently favoured the accumulation of nitrogen as well as its utilization in the leaves, and consequently increased the pigment contents, which were higher than those found in seedling leaves on sand.

Effect of pre-sowing seed treatments. The data in Table 2 show that pre-sowing seed treatments stimulated all the characters studied, with the exception of pigment contents, when compared to untreated dry seeds. The stimulation effect was only statistically significant for N% in both plant tops and roots and for P and K% in plant tops and roots, respectively. On the other hand, the uptake of minerals did not differ statistically from the untreated dry seeds.

The increase in pigment contents in tomato seedling leaves grown from dry seeds, despite the fact that the plant top had a lower N% than that of the pre-sowing treatment, may have resulted from the depressive effect of dry seeds on growth, resulting in an accumulation of pigments as a result of a reduction in their distribution and utilization in the leaves.

Regarding the favourable effect of pre-sowing seed treatments on mineral status, the present results agreed with those obtained by GAAROV (1968), who reported that pre-sowing soaking of seeds in water resulted in higher absorption of both water and N by the plants

Table 2

Effect of soil types, seed treatments and their interaction on mineral status and leaf pigment contents

Soil type	Seed treatments	Mineral uptake, mg/seedling			Mineral contents, %						Pigment contents, mg/l				
					Plant tops			Plant roots			chl. a	chl. b	chl. a + b	chl. a : b	carot-enoids
		N	P	K	N	P	K	N	P	K					
Sand	Dry seeds	13.09	4.09	19.06	2.70	0.856	3.86	1.71	0.58	2.90	1.93	1.00	2.93	1.93	0.65
	Seeds soaked in water	13.53	4.22	20.52	2.73	0.862	4.07	1.83	0.58	3.03	1.90	0.91	2.81	2.09	0.58
	Seeds soaked in Volldünger	14.19	4.43	20.36	2.66	0.875	4.05	1.82	0.61	2.98	1.79	0.98	2.77	1.83	0.64
	Mean for sand	13.60	4.25	19.98	2.70	0.864	3.99	1.79	0.59	2.97	1.87	0.97	2.84	1.95	0.62
Loamy sand	Dry seeds	11.29	2.50	16.05	3.28	0.703	4.20	1.93	0.53	4.47	2.32	1.20	3.52	1.93	0.77
	Seeds soaked in water	11.50	2.47	15.96	3.28	0.687	4.35	2.01	0.50	4.36	2.10	1.09	3.19	1.93	0.64
	Seeds soaked in Volldünger	12.31	2.61	17.24	3.33	0.695	4.30	2.07	0.54	4.64	2.27	1.11	3.38	2.05	0.73
	Mean for loamy sand	11.70	2.53	16.42	3.30	0.692	4.34	2.00	0.52	4.49	2.23	1.13	3.33	1.97	0.71

Mean for seed treatments

	Dry seeds	12.19	3.29	17.56	2.99	0.78	4.10	1.82	0.56	3.69	2.12	1.10	3.22	1.93	0.71
	Seeds soaked in water	12.51	3.35	18.24	3.00	0.77	4.14	1.92	0.54	3.70	2.00	1.00	3.00	2.01	0.61
	Seeds soaked in Volldünger	13.25	3.52	18.80	3.10	0.80	4.20	1.94	0.57	3.81	2.03	1.05	3.08	1.94	0.68
Seed treatment (S)		n.s.	n.s.	n.s.	*	*	n.s.	*	n.s.	*	n.s.	*	n.s.	n.s.	***
Soil type (T)		**	***	***	***	***	***	***	***	***	***	***	***	n.s.	***
S × T		n.s.	n.s.	n.s.	*	*	n.s.	*	n.s.	*	n.s.	*	n.s.	n.s.	***

Table 3

Effect of seed treatments × nutrient ratios on mineral status and leaf pigment contents

Seed treatments	NPK ratio	Mineral uptake, mg/seedling			Mineral content, %						Pigment contents, mg/l				
					Plant tops			Plant roots			chl. a	chl b	chl. a + b	chl. a : b	carot-enoids
		N	P	K	N	P	K	N	P	K					
Dry seeds	1 : 1 : 1	10.45	3.05	16.59	2.58	0.75	4.01	1.72	0.55	3.17	2.04	1.08	3.12	1.89	0.71
	1 : 1 : 2	8.81	2.74	16.72	2.28	0.66	4.00	1.42	0.59	3.86	2.06	1.10	3.16	1.87	0.70
	1 : 2 : 1	11.69	3.62	18.87	2.60	0.81	4.05	1.73	0.58	3.58	1.91	0.97	2.88	1.97	0.67
	1 : 2 : 2	10.15	3.32	17.61	2.62	0.81	4.33	1.65	0.60	3.58	1.63	0.85	2.48	1.91	0.59
	2 : 1 : 1	15.82	3.56	17.56	3.53	0.76	3.72	2.08	0.52	3.61	2.06	1.05	3.11	1.96	0.67
	2 : 1 : 2	14.58	3.51	21.19	3.28	0.73	4.38	2.02	0.53	4.13	2.39	1.22	3.60	1.97	0.79
	2 : 2 : 1	13.03	3.35	16.82	3.35	0.84	4.02	2.00	0.56	3.68	2.47	1.17	3.63	2.10	0.76
	2 : 2 : 2	13.02	3.19	15.12	3.68	0.89	4.32	1.97	0.55	3.88	2.44	1.43	3.87	1.71	0.77
Seeds soaked in water	1 : 1 : 1	10.40	3.01	17.54	2.60	0.73	4.17	1.72	0.55	3.68	1.77	0.93	2.69	1.90	0.56
	1 : 1 : 2	10.60	2.78	17.51	2.43	0.66	4.15	1.70	0.53	3.72	1.93	1.00	2.93	1.93	0.65
	1 : 2 : 1	11.47	3.79	18.42	2.77	0.89	4.23	1.72	0.57	3.36	1.94	0.93	2.87	2.09	0.57
	1 : 2 : 2	13.11	3.82	21.35	2.73	0.81	4.28	1.83	0.57	4.04	1.98	0.95	2.92	2.08	0.59
	2 : 1 : 1	14.08	3.22	16.65	3.40	0.73	3.78	2.07	0.51	3.45	1.83	0.89	2.73	2.06	0.53
	2 : 1 : 2	14.62	3.57	21.78	3.13	0.74	4.41	1.92	0.46	3.83	2.01	1.02	3.03	1.96	0.59
	2 : 2 : 1	13.89	3.48	17.27	3.42	0.80	3.94	2.20	0.57	3.77	2.30	1.16	3.46	1.98	0.71
	2 : 2 : 2	12.55	3.10	15.41	3.55	0.84	4.17	2.18	0.57	3.74	2.24	1.12	3.36	2.00	0.70
Seeds soaked in Volldünger	1 : 1 : 1	11.39	2.99	17.52	2.70	0.72	4.05	1.88	0.57	3.82	2.04	0.97	3.01	2.10	0.72
	1 : 1 : 2	9.79	3.21	19.08	2.32	0.73	4.30	1.80	0.58	4.03	2.08	1.02	3.10	2.04	0.74
	1 : 2 : 1	12.84	3.92	19.70	2.90	0.86	4.28	1.80	0.59	3.63	1.76	0.91	2.67	1.93	0.71
	1 : 2 : 2	12.54	3.58	20.71	2.85	0.79	4.51	1.77	0.59	3.92	1.98	1.03	3.01	1.92	0.55
	2 : 1 : 1	13.92	3.23	17.01	3.37	0.74	3.79	1.93	0.52	3.56	1.98	1.09	3.07	1.82	0.64
	2 : 1 : 2	13.74	3.40	21.12	3.02	0.70	4.41	2.15	0.56	4.12	2.08	1.16	3.23	1.79	0.68
	2 : 2 : 1	14.95	3.85	16.21	3.43	0.86	4.04	2.40	0.60	3.72	2.17	1.12	3.29	1.94	0.71
	2 : 2 : 2	16.85	3.94	19.08	3.40	0.89	4.24	1.82	0.57	3.72	2.17	1.06	3.23	2.05	0.73
		n.s.	*	n.s.	n.s.	n.s.	n.s.	*	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.

VARIATION

[illegible]

produced, more protein and messenger RNA, and faster reconstruction of polyribosomes after hardening. Moreover, the present results might be due to an increase in the root/shoot ratio (MAY *et al.* 1962), and/or to the increase in root area (WOODRUFF 1969, 1973).

Effect of soil types \times seed treatments. As presented in Table 2, soil types \times seed treatments did not reflect any significant differences in the characters studied, with the exception of K% in plant tops, which was significantly affected by the interaction. Treated seeds in loamy sand were most highly stimulated, followed by dry seeds in the same soil, then seeds in sand.

Effect of seed treatments \times nutrient ratios. The data reported in Table 3 show that with the exception of total P uptake and N% in plant roots, which differed significantly as affected by the interaction of seed treatments and nutrient ratios, the other characters studied were not significantly affected. Moreover, the combination 1 : 1 : 2 was depressive for P uptake and N% in roots though it did not differ significantly from some treatments.

Effect of soil types \times nutrient ratio. Generally, in both sand and loamy sand soils both total P uptake and P% in plant tops decreased as the K ratio in the soil increased, but increased as P increased (PROHÁSZKA—HAMAR 1977). Moreover, the increase in N ratio in the soil resulted in an increase in both P uptake and its concentration (THOMAS—HEILMAN 1967) in sandy soil but resulted in a decrease in both in loamy sand (PROHÁSZKA—HAMAR 1977). It is also interesting to mention that the increase or decrease in P uptake or its concentration were proportionately significantly the same whether the N—P or K ratios were doubled or not in loamy sand, whereas in sand the different ratios of nutrient treatments caused hardly significant differences (Table 4).

Effect of soil types \times seed treatments \times nutrient ratios. Correlation coefficients and linear regressions were calculated as effects by the interaction of the above factors for the relationship between fresh weight and N% as independent variables and leaf pigment contents as dependent variables. The data reveal that carotenoids and chlorophyll *a* + *b* were negatively correlated with the fresh weight of seedlings, $r = -0.30^*$ and -0.35^{**} , respectively, but were positively correlated with N% in seedlings tops, $r = 0.28^*$ and 0.56^{***} , respectively. Moreover, the whole nutrient status of the plant, and chlorophyll *a*, *b* and *a* : *b* were not significantly affected by the interaction of the 3 factors studied, but chlorophyll *a* + *b* and carotenoids were affected. The treatments 2 : 2 : 1 and 2 : 2 : 2 stimulated the total chlorophyll content to the greatest extent in the case of the two soils in all seed treatments compared to the respective treatments within the same seed treatment, except for seeds soaked in Volldünger in loamy sand, where 1 : 1 : 2 was the best treatment. Treatments in sand soil only differed significantly for the combinations 1 : 2 : 2, 1 : 1 : 1 and 1 : 1 : 2 with dry seeds, seeds soaked in water and seeds soaked in Volldünger, respectively, in loamy sand, and only differed significantly for the combinations 1 : 1 : 1 and 1 : 2 : 2 with dry seeds and 1 : 2 : 1 with seeds soaked in Volldünger. Moreover, it can be concluded that the available nutrient combination ratios 2 : 2 : 1 and 2 : 2 : 2 with dry seeds and 1 : 1 : 2 with seeds soaked in Volldünger in loamy sand soil were in general the most favourable treatments with respect to chlorophyll and carotenoid contents which relatively had the same trend in tomato leaves.

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**EFFECT OF 2,4-DICHLOROBENZYL TRIBUTYL PHOSPHONIUM
CHLORIDE (PHOSFON-D) ON GROWTH, FLOWERING
AND YIELD OF OAT IN A POT CULTURE**

2,4-dichlorobenzyl tributyl phosphonium chloride (Phosfon-D) is one of the most active and widely used commercial height retardants (PRESTON—LINK 1958, CATHEY 1964). In addition to height retardation activity, Phosfon treatments induce bud set and proliferation of buds in azaleas, rhododendron and camellias (STUART 1961, 1962). On plants of *Euonymus Japonicum* Thump (evergreen burning bush) low doses were without effect, but higher ones stimulated growth or were toxic. However, the effects of Phosfon and their mode of application are species specific.

Considering the importance of Phosfon-D in various plant species, it was felt that it might be of practical value for increasing yield under heavy fertilization conditions without fear of lodging in oat plants, which are extensively grown in India as a fodder crop during the "rabi" season. So the aim of the present study was to determine the effect of Phosfon-D on growth, flowering and yield components of oat when applied as a foliar spray or soil drench.

The experiment was conducted at the Indian Grassland and Fodder Research Institute, Jhansi, during the year 1976—77 in a pot culture with 7 treatments of Phosfon-D including untreated (control) plants.

Table 1

Average shoot length (cm) of untreated and Phosfon-D treated oat (Avena sativa L.) plants, recorded at 20 day intervals; Phosfon-D applied as foliar spray and as soil drench

Treatment	Days after treatment					Increase or decrease over control
	20	40	60	80	Mean	
Untreated (control)	12.20	20.41	58.08	68.13	39.70	—
Foliar spray:						
10 ppm Peosfon-D	11.60	19.00	49.66	64.31	36.14	(—) 8.97
100 ppm Phosfon-D	12.78	19.80	50.15	63.35	36.52	(—) 8.01
1000 ppm Phosfon-D	13.17	17.13	42.76	66.91	34.99	(—) 11.86
Soil drench:						
10 ppm Phosfon-D	14.70	19.48	59.91	63.75	39.46	(—) 0.60
100 ppm Phosfon-D	15.03	20.75	56.50	60.95	38.21	(—) 3.75
1000 ppm Phosfon-D	13.42	16.91	36.83	68.71	33.97	(—) 14.43
Mean	13.27	19.07	50.55	65.16		

	Concentration	Age	Interaction
C.D. at 5% level	3.315	2.506	6.632
C.D. at 1% level	4.369	3.303	8.743

Healthy seeds of oat var. IGFRI 3021 were sown in porcelain pots (45 × 30 cm) filled with a soil manure mixture (3 : 1). Additional fertilizers, namely urea, superphosphate and potassium, were given at 120 kg, 30 kg and 25 kg/ha. Superphosphate and potassium were applied at the time of sowing only, whereas nitrogen was given in two split doses, with 40 kg/ha as basal dressing along with P_2O_5 and K_2O and the remaining 80 kg/ha later on as top dressing. Each pot contained 5 seedlings, which were later thinned to three. All culture operations, watering, etc. were given regularly. Fifty five days after sowing, the plants were treated with Phosfon-D in the following ways:

1. Control (untreated)
2. 10 ppm Phosfon-D foliar spray
3. 100 ppm Phosfon-D foliar spray
4. 1000 ppm Phosfon-D foliar spray
5. 10 ppm Phosfon-D soil drench
6. 100 ppm Phosfon-D soil drench
7. 1000 ppm Phosfon-D soil drench

Observations on growth were recorded at 20 day intervals. Flower emergence, the completion of ear emergence at the 50% flowering stage and the earhead ripening were also recorded. At the time of final harvest, the yield contributing characters were also examined.

Growth responses. The data presented in Table 1 clearly indicate that the growth retarding effect did not become marked until 40 days after the treatments. The shoot length was reduced in all the concentrations compared to the control, the degree depending upon the concentrations used. However, 0.60 to 14.43% retardation was obtained with the various concentrations of the chemical, the maximum being at 1000 ppm. In general, the effects of concentration, age and their interaction were highly significant.

Table 2

Average root length (cm) of untreated and Phosfon-D treated oat (Avena sativa L.) plants, recorded at 20 day intervals; Phosfon-D applied as foliar spray and as soil drench

Treatment	Days after treatment					Increase or decrease over control
	20	40	60	80	Mean	
Untreated (control)	41.66	53.58	36.95	41.11	44.00	—
Foliar spray:						
10 ppm Phosfon-D	47.00	50.58	39.58	36.78	43.48	(-) 1.18
100 ppm Phosfon-D	50.00	68.25	34.33	43.60	49.04	(+) 11.45
1000 ppm Phosfon-D	44.08	51.91	49.16	35.73	45.22	(+) 2.77
Soil drench:						
10 ppm Phosfon-D	40.83	42.45	46.50	42.76	43.13	(-) 1.98
100 ppm Phosfon-D	59.91	39.66	47.91	38.70	46.54	(+) 5.77
1000 ppm Phosfon-D	54.10	36.91	56.91	36.33	46.06	(+) 4.68
Mean	48.22	49.05	44.86	39.29		

	Concentration	Age	Interaction
C.D. at 5% level	N.S.	6.165	10.992
C.D. at 1% level	N.S.	8.126	14.489

Table 3

Effect of Phosfon-D (2,4-dichlorobenzyl tributyl phosphonium chloride) on flowering responses of oat (Avena sativa L.) plants

Treatment	Days required after treatment for		
	Flower emergence	Completion of ear emergence	Ear ripening
Untreated (control)	47	54	147
Foliar spray:			
10 ppm Phosfon-D	33	41	120
100 ppm Phosfon-D	36	43	126
1000 ppm Phosfon-D	38	48	128
Soil drench:			
10 ppm Phosfon-D	40	49	135
100 ppm Phosfon-D	42	44	137
1000 ppm Phosfon-D	45	52	142

The average root length of untreated and Phosfon treated plants was also observed at successive stages of growth and presented in Table 2. In general, root length increased more in soil drench treatments than after foliar sprays. However, the mean root length in treated and untreated series of plants increased up to 40 days and subsequently decreased with an increase in age. This is only natural, since the roots decomposed at the maturity stage. In general, the root length increased from 2.77 to 11.45% compared to the control and statistically the age and interaction effects were significant.

Flowering and fruiting behaviour. In order to find out if the Phosfon-D treatments affect flowering in oat plants the time taken by the plants from ear emergence up to ear ripening was recorded. It was observed that in untreated control plants, flowering took place 47 days from the time of treatment when the first ear emerged. In the case of foliar sprays the ear emergence was enhanced by 9 to 14 days compared to the control. Similarly, ear emergence was 2 to 7 days earlier when Phosfon-D was applied to the soil. The completion of ear emergence was also affected by the treatments, and the time taken by the ears to ripen was hastened in most of the treatments (Table 3).

Yield contributing characters. Characters associated with yield were recorded at harvest and presented in Table 4. The total number of tillers per plant was increased greatly with Phosfon-D treatments. In the case of foliar sprays, the maximum tiller number was recorded in the 100 ppm treatment followed by 10 ppm, whereas 1000 ppm decreased the tiller number again, although it was still better than the control. In the case of soil drench treatments the concentration effect was much more pronounced than in the control. The tiller number rose with an increase in concentration but was considerably reduced at 1000 ppm. The fertile tillers per plant were also examined and it was observed that the number of ear bearing tillers per plant (fertile) increased significantly in response to Phosfon-D treatments as against the untreated control. Panicle length increased significantly in the 100 ppm soil drench treatment followed by 100 ppm foliar spray in comparison to the control. The other two concentrations of soil drench treatments also increased panicle length to some extent but the lower and higher dosages of foliar spray decreased it. The latter was much more effective than the former (Table 4).

The number of grains per panicle increased up to 100 ppm in the foliar spray and soil drench treatments but the highest concentration (1000 ppm) decreased it greatly, although the number of grains per panicle increased significantly compared to the untreated control plants. In a similar way the grain weight per panicle also differed significantly and gave higher values than the control. The grain weight per plant also increased in almost all cases of

Table 4

Certain plant characteristics associated with yield recorded on Phosfon-D treated oat (Avena sativa L.) plants relative to untreated control; observation recorded at harvest; 114 days after spray or soil drench treatments in a pot culture

Treatment	Tiller number	Fertile tillers	Panicle length (cm)	Number of grains per panicle	Grain weight per panicle (g)	Grain weight per plant (g)	1000 grain weight (g)	Harvest index
Untreated (control)	15.17	9.50	23.52	68.17	1.23	8.47	10.17	30.70
Foliar spray:								
10 ppm Phosfon-D	15.67	8.83	23.05	96.33	1.97	7.58	10.33	35.46
100 ppm Phosfon-D	16.83	11.00	26.00	116.17	2.45	10.42	10.67	35.75
1000 ppm Phosfon-D	15.33	10.00	23.02	83.50	1.67	8.68	10.33	33.85
Soil drench:								
10 ppm Phosfon-D	18.00	9.83	26.27	113.50	2.15	8.57	10.17	27.61
100 ppm Phosfon-D	19.50	11.17	26.98	117.67	2.28	10.63	10.67	37.55
1000 ppm Phosfon-D	17.67	11.00	25.03	81.33	1.77	8.45	10.17	30.82
C.D. at 5% level	N.S.	1.11	1.90	1.65	0.58	1.35	0.68	5.71
C.D. at 1% level	N.S.	1.48	2.57	2.22	0.78	1.83	N.S.	N.S.

foliar spray and soil drench treatments except for the 10 ppm foliar spray treatment. The effect was more pronounced in soil drench treatments than in foliar sprays, in general. Overall, the treatment differences were statistically significant (Table 4).

Apparently there was not a big increase in 1000 grain weight, but the 100 ppm foliar spray and soil drench treatments gave higher test weights than the control. Other concentrations caused a slight improvement or were at par with the control. However, the results were only significant at the 5% level. The harvest index was also affected with various concentrations of Phosfon-D treatments. The treatment differences as compared to the control were significant (Table 4).

The shoot length reduction may be due to inhibition of cell division and elongation (SACHS *et al.* 1960, SACHS—WOHLARS 1964). Growth retardants also inhibit the biosynthesis of gibberellin, which may possibly be the cause of growth retardation in the present investigation (LANG 1970).

Root length was increased by certain Phosfon-D treatments in the study. This clearly indicates that, being a growth retardant, it may not act exclusively as a growth inhibitor. It may also stimulate growth under certain conditions. No explanation is offered for these extraordinary results, where the effect of a growth retardant on root elongation is parallel to levels of auxins. However, similar types of observations have also been obtained in petunia, where Phosfon produced a sparser root system than in plants grown in untreated soil. STURM—JUNG (1964) also observed that wheat plants treated with CCC (another growth retardant) had larger root systems.

Early flowering was also observed by CATHEY—STUART (1961), FURUTA (1963), SHANKS—LINK (1963), NANDA *et al.* (1969) and YADAVA—SREENATH (1975) in a number of plants under the influence of growth retardants. It is quite likely that with the passage of time the growth retardants present in the plants get down to such a level that they may influence the early emergence of flowers. After all, it was the lower concentrations of Phosfon-D that helped in the flowering of oats.

The curtailment of vegetative growth by the application of Phosfon-D resulted in better seed setting, as observed by the average increase in grain yield. This increase in yield was directly associated with the increased number of grains, 1000 grain weight and inner components in the grains. Similar results have also been reported by SARIN—UPRETY (1965)

and other authors on various crops. HUMPHRIES *et al.* (1965) attributed the increase in grain yield to more solar radiation reaching the lower parts of the growth retardant-treated shortened plant, promoting the development of branching and newer shoots. The results of the present investigations are in conformity with the above findings and of those reported earlier in other crops (BHATT—NATHAN 1968, RAO *et al.* 1976).

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OBSERVATIONS ON CODLING MOTH FECUNDITY, EGG PRODUCTION AND LONGEVITY

On a world-wide basis the larva of the codling moth, *Laspeyresia pomonella* L., is the major insect pest of apples.

It is only in the last 15 years that entomologists have tried to develop a practical long-term solution to this pest problem. The present paper reports the results of observations on fecundity, number of oocytes, rate of egg production and moth longevity for two codling moth populations, which provide details for studying the population dynamics of this pest species.

GEHRING—MADSON (1963) reported that in laboratory tests the pre-oviposition period was approximately one day, the peak of oviposition occurred by the fourth day, and the females were reproductively old after the sixth day.

PROVERBS *et al.* (1967) reported that the number of eggs per female was 150 when rearing took place in a greenhouse controlled at $26 \pm 1^\circ\text{C}$ and approximately 70% R.H. Under these conditions the adult longevity was 11 days in the case of males and 9 days in females.

DESEÖ (1970) reported that immediately after emergence *Laspeyresia pomonella* L. females already contain mature oocytes and in each maturing follicle there are 7 nurse cells. This author also found that different constant temperatures (18, 23, 28°C) during the whole ontogenesis did not exert any influence on the number of oocytes found in the females or on their egg-production, and that the number of oocytes per ovariole in females 10 days after emergence was on average 28, 30 and 31 at 28, 23 and 18°C , respectively.

WHITE—HUTT (1970) reported that the average longevity of male and female codling moths was 10.5 and 8.1 days at 26°C and 60% R.H. associated with a photoperiod of 16 hours and 8 hours dark. Under these conditions, the number of eggs per female ranged between 54 and 107.

HATHWAY *et al.* (1971) studied the development and fecundity of codling moths reared on artificial diets or on immature apples; the conditions used in the experiments were $26.7 \pm 2^\circ\text{C}$, 50% R.H. and a 16 hour photophase. The female longevity was 7.1 days and the male

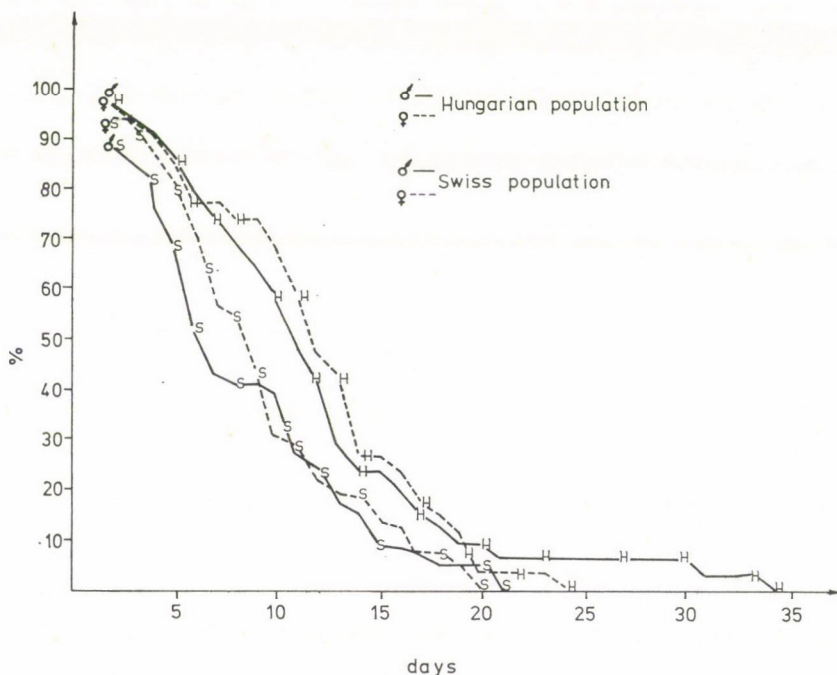


Fig. 1. Male and female survival

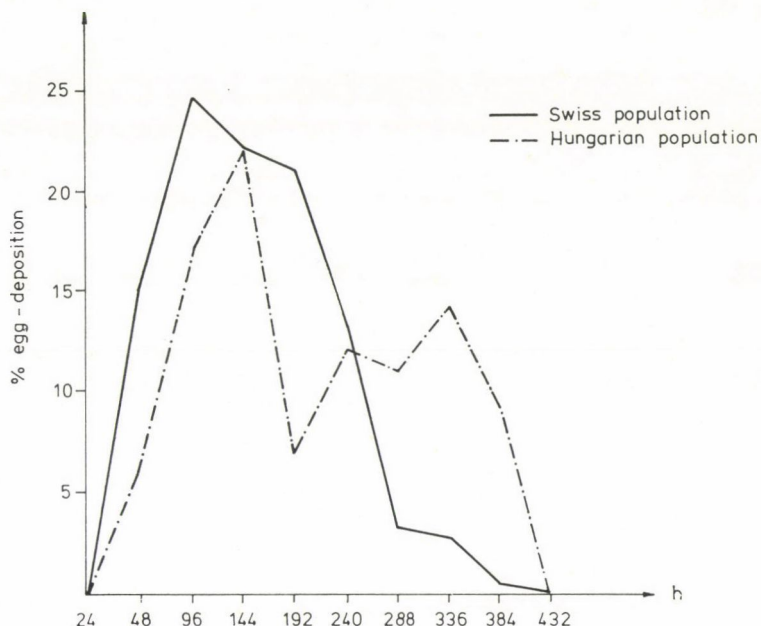


Fig. 2. Percentage of eggs laid per female in two populations

life-span was 7.0 days, both being reared on immature apples. The average egg production per female was 75.7.

HAGLEY (1972) observed a variation between male and female longevity, the average life span of 5 males and 5 females reared at 10°C was 51 and 58 days, respectively.

Of the two codling moth populations used in this experiment one originated from a Swiss laboratory population (Var-Wädensvil), while the second was obtained from diapausing larvae collected from an orchard at Budaörs (Hungary) in January 1978 by means of corrugated paper strips tied to the trunks in late summer 1977. The larvae in the first population were reared on immature apples and the colony was maintained in a controlled environment cabinet at $28 \pm 2^\circ\text{C}$, $70 \pm 5\%$ R.H. and 17/7 hours L/D photoperiod. As the mature larvae left the apples they were allowed to spin cocoons in narrow strips of corrugated paper. The corrugated strips were then placed in glass jars and left in the insectary with the strips collected from the orchard.

The emergence of male and female adults for the two populations was recorded daily, and the adults were kept in pairs in cylindrical screen cages about 15 cm long and 8 cm in diameter, provided with narrow strips of polyethylene for oviposition. Each cage was supplied with dental cotton soaked in 5–10% honey-water that was remoistened daily. The cages were kept in the environment cabinets mentioned above.

The data on which oviposition commenced was recorded, and the eggs were removed and counted daily. The longevity of adults in the oviposition cages was recorded, the dead females were dissected and the oocytes and nurse cells of the follicles were made discernible by using the staining method described by DESEŐ (1970). The differentiated follicles were regarded as a reliable indication of the number of eggs which could potentially be laid by a female (DESEŐ—SÁRINGER 1970).

The longevity data presented in Fig. 1 show that the life span is longer in females than in males for the two populations. Figure 1 also shows survival curves for the males and females of the two populations. It is evident that even during the first week, the survival rate of the Swiss population is lower than that of the Hungarian population. On the sixth day, for example, the mortality rate is 30% among females and 49% among males of the Swiss population, while in the Hungarian population it is 23% and 21% for females and males respectively. More than 50% of the females in the Swiss population had died within 8 days and 50% of the males within 7 days, while in the Hungarian population these figures were

Table 1

Egg production of a Hungarian codling moth population

No. of pair	Hours after emergence	48		72		96		144	
		No. of eggs	eggs/hr	No. of eggs	eggs/hr	No. of eggs	eggs/hr	No. of eggs	eggs/hr
1		0	0	6	0.08	3	0.12	22	0.5
2		0	0	2	0.02	1	0.04	18	0.40
3		0	0	25	0.34	0	0	49	1.02
4		0	0	9	0.12	0	0	0	0
5		32	0.66			4	0.08		
6		0	0	0	0	0	0	0	0
7		0	0	0	0	0	0	0	0
8		0	0			25	0.26	15	0.31
9		0	0	6	0.25	0	0	0	0
10		0	0	0	0	0	0	0	0

11 and 12 days respectively for females and males. The life-span is also longer in Hungarian females (24 days) and males (34 days) than in the females (20 days) and males (21 days) of the Swiss population.

These differences appear to be due to the difference in the origin of the two populations, and may also be caused by differences in food quality, because the Hungarian population was reared on fresh apples under natural conditions while the Swiss population was reared on immature apples in a thermostat.

BRINTON *et al.* (1969) found that the average longevity of males and females reared on an artificial medium was shorter than that of insects reared on apples, being 15 days for males and 10 days for females reared on the artificial medium, but 18 days for males and 13 for females when reared on apples. The author assumed that this was partly due to differences in the food.

HAGLEY (1972) showed that the maximum life span of 5 males and 5 females reared at 15°C was 90 and 99 days, respectively.

The data concerning egg production are given in Tables 1 and 2. Females start egg-laying on the second and third day for the Hungarian and Swiss populations, respectively, and only a few cases were observed when oviposition was delayed or took place a day earlier.

Eggs were laid either singly or in small batches of 2–20 eggs. Egg-laying took place continuously every day throughout the oviposition period, though it may have been interrupted or have ceased for an interval of one day, as is very clear in the Hungarian population.

The percentage of egg-laying over the oviposition period is shown in Fig. 2. The percentage of egg-laying was high during the 6 days after the pre-oviposition period and the maximum was reached on the second and fourth days for the Swiss and Hungarian populations, respectively. Subsequently the egg-laying percentage decreased gradually over a maximal period of 18 days, while the Hungarian population shows a fluctuation in the decreasing rate.

From the same figure it is evident that in the Swiss population the egg-laying is quicker, with more than 50% (58.1%) having been laid by the sixth day after emergence, while in the Hungarian population 54.5% was not reached until the eighth day after emergence.

From Tables 1 and 2 the maximum number of eggs/hr (3.37) was observed between 3–7 days after the pre-oviposition period in the Swiss population. The maximum number of eggs for the Hungarian population was 1.02. There is a great difference between the two populations in the reproductive activity (Table 3); in the Hungarian population the mean fecundity was 39 eggs/female, and in the Swiss population it was 137 eggs/female, and in the laboratory investigations a considerable part of the overwintered Hungarian population failed to oviposit.

BULYGINSKAYA—SOKOLOVA (1969), in a comparison of laboratory and field populations of codling moth, observed that in larvae reared at 26–27°C and 18 hours day light, the

per day (or two days) and per hour throughout the life span

192		240		288		312		360	
No. of eggs	eggs/hr	No. of eggs	eggs/hr	No. of eggs	eggs/hr	No. of eggs	eggs/hr	No. of eggs	eggs/hr
4	0.07	0	0	9	0.12				
2	0.03	0	0	6	0.08	19	0.18	6	0.12
13	0.29	0	0	36	0.3				
0	0	0	0	10	0.13				
8	0.08	0	0						
0	0	0	0	0	0		3	0.12	
		3	0.02					33	0.34
0	0	0	0			3	0.03	0	0
		54	0.45			39	0.40		

fecundity and sexual activity of the adults in the field population were much lower than those of laboratory-bred adults, with the fecundity of the laboratory-bred females being at least 2—3 times higher.

The total number of oocytes per female that was taken into consideration varied for the different populations, being 208 for the Hungarian and 103 for the Swiss population, but there is no difference in the "possible" number of eggs per female, whether the female deposited a large or small number of eggs (see Table 3).

All the differences between the two populations were due to differences in adaptation to the laboratory conditions, and because the Hungarian population was an overwintered generation. This meant that its egg and larval development occurred during a short photophase in the field, and this seemed to influence the reproductive activity of the females.

Table 2

Egg production of a Swiss population per day and per hour throughout the life span

No. of pair	Hours after emergence		24		48		72		96		120	
	No. of eggs	eggs/hr	No. of eggs	eggs/hr	No. of eggs	eggs/hr	No. of eggs	eggs/hr	No. of eggs	eggs/hr	No. of eggs	eggs/hr
1	0	0	65	1.35	27	1.12	59	2.26	28	1.16		
2	0	0	0	0	0	0			9	0.19		
3	0	0	0	0			77	1.60				
4	0	0	100	2.08	17	0.60	35	1.84	15	0.15		
5	0	0	2	0.04	1	0.40	56	2.55	39	1.44		
6	0	0	0	0	113	2.22	19	0.79				
7	0	0	0	0	0	0	0	0	1	0.04		
8	0	0	0	0	0	0	0	0	0	0		
9	6	6.26	7	0.3	31	1.4					38	0.76
10	0	0	0	0	0	0					64	1.18

No. of pair	Hours after emergence	144		168		192		216		240	
		No. of eggs	eggs/hr	No. of eggs	eggs/hr	No. of eggs	eggs/hr	No. of eggs	eggs/hr	No. of eggs	eggs/hr
1				42	0.91	14	0.48	7	0.36	4	0.13
2		10	0.35	0	0	18	0.66	41	1.70	27	1.22
3		45	0.95			27	0.56	30	1.75	1	0.03
4		8	0.33	0	0	0	0	0	0		
5		44	1.83	48	2.28			49	0.98	0	0
6		26	0.52	0	0	0	0				
7		1	1			152	3.37	13	0.52	4	0.17
8		0	0	5	0.2	12	0.44	3	0.12	0	0
9		1	0.11	8	0.33						
10		36	1.5	18	0.75	24	1			58	1.16

No. of pair	Hours after emergence	264		288		312		336		360	
		No. of eggs	eggs/hr	No. of eggs	eggs/hr	No. of eggs	eggs/hr	No. of eggs	eggs/hr	No. of eggs	eggs/hr
1		2	0.08	0	0						
2				5	0.10	3	0.12	0	0	17	0.73
3		37	1.54	3	0.14			20	0.40	1	0.03
4											
5		0	0								
6											
7		0	0	0	0						
8		0	0	0	0	0	0	5	0.2	1	0.04
9											
10		6	2.3	7	0.30			20	0.47	4	0.14

DESEŐ (1971) also observed that the mean fecundities of the overwintered codling moth populations were considerably lower (17—23 eggs) than those of the generation swarming in summer (76—83), and this phenomenon results from three factors: 1. The mating frequency is reduced after diapause. 2. After diapause only about one third of the mated females lay eggs. 3. The number of eggs per fertilized female is also low after diapause.

These observations indicate that the reproductive activity of the codling moth is regulated by the "external" conditions, but these do not influence the "possible" number of eggs.

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Table 3
Reproductive activity of codling moths in different populations

Populations	No. ♀♀	Mean fecundity (No. of eggs laid/♀)	Total number of oocytes/♀	"Possible"* egg number
H. no egg-laying	10	—	246	246
H. egg-laying	10	39	208	247
S. egg-laying	48	137	103	240
10 days after emergence (Deseő 1970)	86	—	224	224

* "Possible" number of eggs = Total number of oocytes/♀ (determined by dissecting the females) + No. of eggs laid/♀.

H = Hungarian population

S = Swiss population

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INTERGENOTYPIC COMPETITION IN JUTE (CORCHORUS SPP)

The phenotypic expression of a genotype may be modified in either direction due to the "neighbouring influence" of another genotype constituting an additional component of the environment. The magnitude and direction of phenotypic modifications depend on the competing genotypes. Many investigators have studied intergenotypic competition, usually in artificial mixtures of several varieties of various crop plants (SANDFAER 1970, BANERJEE *et al.* 1971, SASMAL 1976, PANJA 1977). Work along these lines has, however, not gained prominence in jute, an important bast fibre crop in India. The object of the investigation reported here was to evaluate genetically the competitive ability of five jute genotypes.

Table 1

Mean performance of five jute genotypes in pure stands and in competition

Treatments			Technical height (cm)	Base diameter (cm)	Node No. per plant	Fruit No. per plant	Days to flower	Seed wt. per plant (g)	Fibre wt. per plant (g)	Stick wt. per plant (g)
JRO-632 (D-632)	T-1		319.50	1.81	76.50	17.66	108.33	6.000	15.516	37.583
	T-18		299.33	2.01	71.66	20.53	105.33	5.933	19.100	45.900
	T-24		207.66	1.72	60.88	47.93	96.66	6.216	11.516	33.050
	D-154		284.33	1.85	62.20	41.46	101.33	5.966	11.516	25.033
	T-1		337.33	1.46	66.00	14.80	105.66	7.866	15.400	40.316
	T-18	T-18	296.33	1.90	74.33	25.06	107.33	3.033	17.266	44.383
	T-24	T-24	306.50	2.00	69.88	17.00	103.00	10.766	15.533	40.400
	D-154	D-154	314.33	1.86	71.60	31.06	106.33	6.650	16.750	41.133
	O-632	O-632	305.66	1.98	80.53	8.53	107.66	9.350	20.053	53.116
	T-1	T-18	278.66	1.85	65.40	30.60	103.66	5.900	18.400	44.516
	T-24	T-18	289.66	1.72	62.20	10.73	108.33	2.810	10.033	23.066
	D-154	T-18	304.66	2.14	77.60	18.06	109.66	4.900	19.800	51.500
	O-632	T-18	322.50	1.66	71.40	13.60	109.66	3.916	12.100	25.233
	T-1	T-24	283.50	1.77	67.33	26.46	99.00	6.033	13.216	41.233
	T-18	T-24	271.66	1.98	57.00	50.66	91.00	6.816	12.316	35.216
	D-154	T-24	269.50	1.54	49.66	43.86	101.00	13.950	13.233	33.233
	O-632	T-24	289.33	2.05	60.93	42.76	106.00	4.966	12.166	32.633
	T-1	D-154	261.16	1.93	61.60	29.40	106.00	5.533	10.050	23.933
	T-18	D-154	275.83	2.03	63.33	48.60	106.00	2.866	15.216	37.416
	O-632	D-154	265.83	1.92	70.06	27.73	103.33	6.150	9.533	21.233
	T-24	D-154	256.83	1.55	52.63	25.86	97.00	5.816	10.333	36.500
	T-1	O-632	336.83	1.63	64.60	11.06	108.66	2.500	18.833	54.033
	T-18	O-632	342.16	1.64	78.60	4.86	116.00	3.350	17.516	47.133
	T-24	O-632	301.83	1.54	75.66	13.46	106.66	2.333	16.550	42.983
	D-154	O-632	306.66	1.48	69.53	36.13	106.00	13.966	18.033	49.250
C.D. at 5% level of probability			3.692	0.0005	1.176	1.032	25.800	3.378	0.372	77.131

Table 2a

Analysis of variance of different characters of five jute genotypes due to pure v.s. mixed stands

Source	DF	M.S. values							
		Technical height	Base diameter	Node No. per plant	Fruit No. per plant	Days to flowering	Seed wt. per plant	Fibre wt. per plant	Stick wt. per plant
Treatments	24	1709.617*	0.1167*	190.081*	529.928*	60.380	29.142*	24.022*	276.153
Among pure stands	4	1211.016*	0.1201*	129.516*	685.729*	62.100	2.062*	30.557*	188.333
Among mixed stands	19	1749.712*	0.1212*	212.800*	518.065*	60.711	36.314*	36.506*	305.130
Pure vs. mixed stands	1	2942.200*	0.0176*	0.681	132.136*	47.203	1.199*	0.676*	76.861
Error	48	4.803	0.0008	0.493	0.376	234.465	0.051	0.049	2094.470

* Significant at 5% level of probability.

Table 2b

Analysis of variance of characters showing significant pure v.s. mixed stand differences

Source	DF	M.S. values				
		Technical height	Base diameter	Fibre wt. per plant	Fruit No. per plant	Seed wt. per plant
Treatment	24	1709.617*	0.1167*	34.022*	529.928*	29.142*
Genotype effect	4	258.694*	0.0797*	31.311*	365.416*	82.108*
Average competitive effect	4	5483.511*	0.3132	85.660*	1739.588*	22.650*
Specific competitive effect	16	1128.812*	0.0768*	21.790*	268.641*	17.523*
Error	48	4.803	0.0008	0.049	0.375	0.051

* Significant at 5% level of probability.

Five jute genotypes, namely T-1, T-18 and T-24, reported to be recombinant types selected from a *Corchorus capsularis* × *C. olitorius* cross (BHADURI *et al.* 1975), D-154 and JRO-632 were used in the study.

The treatment combinations were made by combining two genotypes at a time in all possible combinations (i.e. 25 combinations for the total of five genotypes). Among these, five were pure stands. The mixed stands were sown by keeping one genotype in the middle row, which was exposed to competition from another genotype which was sown in the adjacent row on each side. The layout adopted was a randomised block design with three replications. The spacing was 45 cm between the rows and 10 cm between the plants.

Observations on different characters were confined only to the middle row in each treatment to measure the competitive effects of border rows. Data were taken on the following characters: *a*) Technical height (height of the plant from base to the main branching point in cm), *b*) Base diameter (cm), *c*) Number of nodes per plant, *d*) Number of fruits per plant, *e*) Number of days required from sowing to emergence of first flower, *f*) Seed yield per plant (g), *g*) Fibre yield per plant (g), *h*) Stick yield per plant (g).

The mean performance of the different characters of five jute genotypes with their respective C.D. values in pure stand and in competition is presented in Table 1.

ANOVA (Table 2a) shows that characters like technical height, base diameter, fruit number, seed yield and fibre yield per plant give significant pure vs. mixed stand differences, while the other three characters do not show any significant differences, thus indicating that their expression is free from competition effects.

The significant characters have been further analysed by partitioning the treatment sum of squares into genotype effect, average competitive effect and specific competitive effect (Table 2b). The data indicate that genotype, average and specific competitive effects are significant for all these characters.

The average competitive effects have been measured from the average value of two genotypes exposed to competition in different treatments. The results (Table 3a) show that T-18, JRO-632 and D-154 are significantly superior in exerting an average competitive effect in respect of base diameter, fruit number and seed yield per plant, respectively; T-24 exerted a significant average competitive effect in respect of technical height and fibre yield per plant.

The percentage of increase or decrease of values in mixed stands over their respective pure stand values is presented in Table 3b. The genotypes T-18, T-24, D-154 and JRO-632 exerted greater specific competitive effects on T-1 in respect of base diameter and fibre yield per plant. Technical height, base diameter and fibre yield per plant increased when T-18 was surrounded by D-154. The genotypes T-18 and JRO-632 showed a competitive effect on T-24 in respect of base diameter and fibre yield per plant. T-18 showed a competitive effect on D-154 in respect of base diameter, fruit number, seed yield and fibre yield per plant. The genotype JRO-632 showed increased base diameter and fibre yield per plant when surrounded by T-1, T-18, T-24 and D-154.

It is evident from the above results that the genotypes T-1 and JRO-632 respond better in competition than T-24, T-18 and D-154. It is also found that fibre yield increases when D-154 is surrounded (in competition) by T-18 or vice versa.

Table 3a
Estimation of average competitive effects of five jute genotypes

Variety	Average competitive effects				
	Technical height	Base diameter	Fruit No. per plant	Seed wt. per plant	Fibre wt. per plant
T-1	-17.13	+0.03	-6.80	-1.754	+0.741
T-18	-15.71	+0.17	+1.83	-2.496	+2.091
T-24	-21.42	-0.08	-6.85	-1.010	-2.271
D-154	-17.16	+0.01	+4.80	+3.362	+1.571
JRO-632	+ 6.87	+0.05	-8.76	+0.066	-0.949
C.D. at 5% level of probability	3.692	0.0005	1.032	0.378	0.372

Table 3b

Percentage increase or decrease in performance of mixed stands over their respective pure stands

			Technical height	Base diameter	Fruit No. per plant	Seed wt. per plant	Fibre wt. per plant
T-18	T-1	T-18	+ 7.25	— 4.97	— 41.90	+ 49.45	—11.27
T-24	T-1	T-24	+ 4.06	—10.49	+ 3.73	— 76.10	—0.10
D-154	T-1	D-154	+ 1.61	— 2.76	— 75.85	— 10.83	— 7.95
O-632	T-1	O-632	+ 4.33	— 9.39	+ 51.69	— 55.83	—29.23
T-1	T-18	T-1	+ 6.57	+ 7.46	— 48.56	+ 0.55	+ 3.66
T-24	T-18	T-24	+ 4.23	+14.45	+ 47.73	+ 52.26	+47.47
D-154	T-18	T-154	— 1.78	— 6.46	+ 12.03	+ 17.41	— 3.66
O-632	T-18	O-632	+ 3.33	— 1.99	—108.28	+ 16.29	+36.30
T-1	T-24	T-1	+ 7.85	— 2.90	+ 44.79	+ 2.94	+14.76
T-18	T-24	T-18	+11.70	—15.11	— 5.69	— 9.65	— 6.94
D-154	T-24	T-154	+12.40	+10.46	+27.22	—124.42	+14.90
O-632	T-24	O-632	+ 5.95	—19.18	+ 10.78	+ 2.01	— 5.64
T-1	D-154	T-1	+ 8.14	— 4.32	+ 29.08	+ 7.25	+12.73
T-18	D-154	T-18	+ 2.98	— 9.73	— 17.22	— 51.96	—32.12
T-24	D-154	T-24	+ 9.67	+16.21	+ 37.62	+ 25.14	+10.27
O-632	D-154	O-632	+ 6.50	— 3.78	+ 33.11	— 3.08	+16.35
T-1	O-632	T-1	+ 0.14	—11.64	+ 25.27	+ 68.21	—22.29
T-18	O-632	T-18	— 1.43	—12.32	+ 67.16	+ 57.41	—13.74
T-24	O-632	T-24	+10.82	— 5.47	+ 9.07	+ 70.34	— 7.46
D-154	O-632	D-154	+ 9.09	— 1.36	—144.12	— 77.55	—17.09
C.D. at 5% level of probability			3.692	0.0005	1.032	0.378	0.372

Thus, broadly, the five jute genotypes behaved differently when exposed to inter-genotypic competition than their respective pure stands for characters like technical height, base diameter, fruit number, seed and fibre yield per plant, while the other characters, namely node number, days to flowering and stick yield per plant, showed no effect of competition.

Among the genotypes, D-154 showed the greatest average competitive effects in respect of base diameter, fruit number, seed yield and fibre yield per plant followed by T-18, T-1 and JRO-632, whereas T-24 was not able to exert any competitive effect on T-1, T-18, D-154 and JRO-632 in respect of different characters.

Only two genotypes T-18 and JRO-632 registered an increase in technical height when they were exposed to competition by D-154 and T-18, respectively. The base diameter increased in most of the mixed stands. T-18 and JRO-632 in their respective mixed stands gained a competitive advantage in respect of fibre yield.

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EFFECTS OF ROW AND PLANT SPACING ON KENAF YIELD AND ITS COMPONENTS IN THE KENANA AREA OF THE SUDAN

Kenaf (*Hibiscus cannabinus* L.) is an important cordage crop in many parts of the world. Its bast fibres are used for the manufacture of twine, rope, bagging, rugs and other products.

Population density in kenaf is important. Not only does it affect yield, but it affects other desirable agronomic characters as well. In addition to this it helps in the control of weeds and, in certain circumstances, may lead to moisture conservation, which is extremely important under rain cultivation.

This paper presents findings from a three-year field trial on the effect of three inter-row spacings factorially combined with four intra-row spacings on kenaf growth and fibre production.

CRANE *et al.* (1946) in Cuba obtained 3077, 2371 and 1866 kg of fibre per ha from plants grown in 0.20, 0.40 and 0.60 m rows respectively. The average number of plants per square metre were 102, 49 and 33 respectively. WALKER—SIERRA (1950) in Cuba showed that with spacings of 17 and 34 plants per metre in rows 0.01, 0.20 and 0.40 m wide, the closer spacings gave higher yields of fibre per acre in every case. WATKINS (1946) reported that the greatest yields of kenaf fibre per acre were obtained when plants were spaced 0.05 m apart in 0.30 m rows. WILLIAMS (1966) in Nebraska found that the dry matter yields of irrigated kenaf were highest from 0.35 m and lowest from 0.70 m row spacings. Also, a population of 27 plants or more per square metre appeared to be necessary for the production of high yields under conditions of ample moisture and fertility.

HIGGINS—WHITE (1970) found from experiments with five harvest dates that populations of 99,000, 198,000, 296,000 and 395,000 plants per ha did not affect yields of dry matter in the variety Everglad 71. WHITE *et al.* (1971) reported that the greatest change in dry matter yield occurred from 99,000 to 198,000 plants per ha. Yield increases from 198,000 to 296,000 plants per ha were slight and accompanied by approximately 20% mortality.

For kenaf ribbon extraction in the Kenana area, SALIH (1978) found that the two population densities 250,000 and 500,000 plants/ha were recommended with narrow row spacings such as 0.20 or 0.30 m.

The kenaf variety Cubano was planted for three consecutive years on 31st May, 23rd June and 10th June in the first, second and third season respectively.

The spacing experiment included 12 treatment combinations: three row spacings (0.20, 0.30 and 0.40 m) and four plant spacings (0.025, 0.05, 0.075 and 0.10 m) arranged in four randomized blocks.

The seed was planted thick in the rows after being marked and covered with soil by hand. When the plants had reached a height of 15 to 20 cm, they were thinned out to single plants to the proper spacings in the row. All treatments received a presowing watering and were irrigated immediately after sowing. From then on watering continued fortnightly, except when there was adequate rain-fall.

Each treatment was harvested when an average of 10 flowers per plant were in bloom. The stems were cut near ground level, and tied into bundles. After recording the total fresh yield, the leaves, buds and flowers were removed to obtain the green stalk yield. These two operations were carried out immediately after cutting the stems.

A hand-fed decorticator was then used to separate the bark from the wood to give the green ribbons. The fresh ribbon yields from the plots were dried in the sun for nearly a month and weighed for dry ribbon yield.

A representative sample of 10 plants was taken at random from each experimental plot for the determination of height, stem diameter 30 cm above the soil surface, dry ribbon yield per plant and ribbon percentage in the stem.

Year effects were highly significant for yield and the other characters studied, indicating that the variety did not perform consistently across these three environments for two main reasons: *a*) Differences in the sowing dates of the experiment from year to year; *b*) In the second season the experiment was planted, simply by chance, in a shallow area where it was subjected to flooring, caused by heavy rains during July and August; this resulted in the plants being stunted, with poor initial growth. Even though all treatments in the second season experiment had the highest plant stand percentage, they gave the lowest yield of dry ribbon in comparison to the yields of the first and the third seasons.

Table 1

Effect of inter-row and intra-row spacing on the plant stand percentage

Row spacing (m)	Plant spacing (m)	Theoretical No. of plants (10 ³ plants per ha)	Season			Three-season average
			first	second	third	
0.20	0.025	2000	70.5*	85.7	59.6	17.9
	0.05	1000	86.6	82.4	87.3	85.4
	0.075	667	93.4	94.8	83.5	90.6
	0.10	500	93.6	98.4	92.2	94.8
0.30	0.025	1333	57.2	83.4	56.3	65.6
	0.05	667	80.7	76.1	85.66	80.8
	0.075	444	92.5	96.7	94.2	94.5
	0.10	333	93.6	97.6	94.9	95.2
0.40	0.025	1000	70.0	97.3	51.3	72.9
	0.05	500	81.1	87.0	86.2	84.8
	0.075	333	91.0	92.5	95.6	93.0
	0.10	250	95.9	96.8	99.3	97.4
			(± 2.74)	(± 2.65)	(± 2.66)	(± 2.86)
Plant spacing mean	0.25		65.9	88.8	55.7	70.1
	0.05		82.3	81.8	86.4	83.7
	0.075		92.3	94.7	91.1	92.7
	0.10		94.4	97.4	95.5	95.8
			(± 1.58)	(± 1.53)	(± 1.53)	(± 0.95)
Row spacing mean	0.20		86.0	90.3	80.6	85.7
	0.30		81.0	88.3	82.7	84.0
	0.40		84.5	93.4	83.1	87.0
			(± 1.37)	(± 1.32)	(± 1.33)	(± 0.83)

* Means in columns within the table followed by the same letter(s) are not significantly different at the 0.05 level according to Duncan's new multiple range test.

Table 2

Effect of intra-row spacings on kenaf stem diameter and plant height

Plant spacing (m)	Season			Mean
	first	second	third	
a) Stem diameter (mm)				
0.025	8.5	3.9	7.5	6.6
0.05	9.8	5.5	8.2	7.9
0.075	10.6	6.1	8.9	8.6
0.10	11.7	7.5	9.2	9.3
	(±0.11)	(±0.24)	(±0.28)	(±0.19)
b) Stem height (m)				
0.025	2.40	1.24	2.05	1.90
0.05	2.45	1.39	2.05	1.96
0.075	2.53	1.37	2.11	2.00
0.10	2.47	1.44	2.07	1.99
	(±0.34)	(±0.34)	(±0.36)	(±0.22)

* Means in columns within the table followed by the same letter(s) are not significantly different at the 0.05 level according to Duncan's new multiple range test.

The significance of the year \times intra-row spacing interactions for dry ribbon yield and the other characters studied, with the exception of stalk height, indicated that all were influenced mainly by the environmental conditions existing during the period of study.

Row width \times year, as well as plant spacing \times year interactions were not significant for stalk height, indicating that variations in this character are dependent primarily on the plant area provided and to some extent on the prevailing environmental conditions.

Row width \times year, as well as plant spacing \times year interactions for dry ribbon yield per plant and ribbon percentage in the plant were highly significant, indicating that both characters were affected broadly by the environmental conditions as well as by plant competition.

The actual plant stand percentages at harvest during the years of the trial were generally smaller than those expected (Table 1). This could have been the result of greater disturbance to the plants at thinning (HIGGINS—WHITE 1970), infestation of damping-off disease immediately after emergence, or heat canker occurring after thinning (WATKINS 1946).

The average spacing at the time of harvest ranged from 0.035 m in the closest spacing to 0.010 m in the widest spacing. Where a plant is missing for any one of the above-mentioned causes, the adjacent plants are likely to be larger, because of the extra space available for development.

The plant stand percentages increased as the spacing between plants and between rows became wider (HIGGINS—WHITE 1970, WHITE *et al.* 1971).

The stem diameter per plant, as shown in Table 2a, increased rapidly with an increase in spacing between rows. Stem diameter was greater in 0.40 m than in 0.30 and 0.20 m rows in the three years and this was also true for the combined analysis. Similar effects of row spacings on stem diameter were found by other authors.

In all years of the test and also in the combined analysis of the three years the smallest stem diameter was obtained from plants planted at 0.025 m spacings and the largest diameters were given by plants sown at 0.10 m spacings (Table 3a). The differences between the 0.025 m spacing and any of the other 3 spacings, however, were highly significant.

Differences in stem diameter between the years were significant. The smallest stem diameter was found in the second season, and this was due to the effect of water-logging on the plants.

In the first and third season, row and intra-row spacings had no significant effect on the plant height (Tables 2b and 3b), but there was a tendency for an increase in plant height

with wider row spacing and wider plant spacing along the row. In the second season the plant height was significantly increased with increased row spacing and plant spacing. Average plant heights from 0.40 and 0.30 m row spacings were significantly taller than the plant height from 0.20 m spacing and with a significant difference between 0.20 and 0.30 m spacings (Table 2b). The average plant heights from 0.05, 0.075 and 0.10 m plant spacings significantly exceeded the plant height from the 0.025 m spacing (Table 3b). Differences between the plant heights of 0.05, 0.075 and 0.10 m plant spacings were not significant. The combined analysis for the three years showed a similar trend in plant height as in the second season.

The dry ribbon yields from the different inter- and intra-row spacings and their combination for the first, second and third season and the mean of the three seasons are shown in Table 4. In every year of the test the variations in dry ribbon yield per ha due to row spacing were not significant. This result was confirmed by SALIH (1978). The combined analysis for the three years showed that the average yields of the three row spacings were at par.

In the first and second year the differences in dry ribbon yields among the four intra-row spacings were not significant. In the first year the 0.075 m intra-row spacing consistently gave a better dry ribbon yield than the other intra-row spacings.

In the third year of the test, as well as in the pooled analysis, the 0.025 and 0.075 m intra-row spacings were found to be significantly superior in dry ribbon yield to the 0.10 m plant spacing. Differences in yield between 0.075 and 0.05 m and between 0.05 and 0.10 m plant to plant spacings were not significant.

The interaction of row spacing \times intra-row spacing was not significant in the three years or in the pooled analysis. Generally the trial showed that the highest dry ribbon yield per ha could be obtained from any one of these possible combinations of intra- and inter-row spacings: 0.20×0.025 , 0.30×0.025 , 0.40×0.025 and 0.30×0.075 m.

Differences between the mean dry ribbon yield per plant for the three row spacings were significant (Table 5). Under all years of the test and the pooled analysis, the dry ribbon yield per plant was highest at the widest row spacing, 0.40 m, and decreased significantly as the space between rows was reduced. In the second season the difference in dry ribbon yield per plant between the 0.40 and 0.30 m row spacings was not significant, but the plants from the 0.40 m row spacing outyielded those from the 0.30 m row spacing by 23%.

The dry ribbon yield per plant at 0.10 m spacing along the row produced 130%, 61% and 18% over those spaced 0.025, 0.05 and 0.075 m apart respectively. Plants spaced at 0.075 m yielded 95% and 37% more than those planted 0.025 and 0.05 m apart. Plants spaced 0.05 m apart gave 43% extra dry ribbon yield over those at 0.025 m spacing. Generally, as the space between plants along the row increased the dry ribbon yield per plant also increased.

Table 3

Effect of inter-row spacings on kenaf stem diameter and plant height

Row spacing (m)	Season			Mean
	first	second	third	
a) Stem diameter (mm)				
0.20	9.1*	5.0	7.8	7.3
0.30	10.4	5.7	8.4	8.1
0.40	11.0	6.5	9.1	8.9
	(±0.31)	(±0.21)	(±0.25)	(±0.16)
b) Stem height (m)				
0.20	2.42	1.29	2.01	1.91
0.30	2.47	1.37	2.08	1.97
0.40	2.50	1.42	2.11	2.01
	(±0.29)	(±0.29)	(±0.29)	(±0.19)

* Means in columns within the table followed by the same letter(s) are not significantly different at the 0.05 level according to Duncan's new multiple range test.

In all the years, as well as in the combined analysis, the dry ribbon yield per plant was highest at the widest intra-row spacing, 0.10 m, and was reduced significantly as the space between the plants decreased (Table 5). The interaction row spacing \times intra-row spacing was significant in the first season and also in the pooled analysis. Generally, the highest dry ribbon yields per plant were obtained from the spacing combinations 0.40×0.10 , 0.40×0.075 , 0.30×0.10 and 0.30×0.075 m. All were significantly different from each other, and significantly superior to the yield of the other spacing combinations.

In the first season no significant differences were found in the percentage of dry ribbon to green weight due to the effect of various row spacings and intra-row spacings (Table 6). In the second season, the ribbon percentage in the plants was significantly affected by row spacings, but not by plant spacings. Plants from the 0.40 and 0.30 m row spacings produced a higher ribbon percentage than those from the 0.20 m spacing, with no significant difference between the 0.30 and 0.40 m row spacings. In the third season the effect of row spacings on ribbon percentage was the reverse of their behaviour in the second season. Ribbon percentages decreased significantly and consistently as the row spacing and plant spacing became wider.

Table 4

Effects of row width and plant spacing on the dry ribbon yield (kg/ha)

Row spacing (m)	Plant spacing (m)	Season			Three-season average
		first	second	third	
0.20	0.025	3182	1664	3344	2730
	0.05	3270	1740	2730	2580
	0.075	3315	1714	2999	2676
	0.10	2937	1711	2965	2538
0.30	0.025	3208	1583	3346	2712
	0.05	2961	1671	3158	2597
	0.075	3432	1521	3175	2709
	0.10	3075	1623	2575	2424
0.40	0.025	3146	1985	3201	2777
	0.05	3208	1787	2673	2556
	0.075	3368	1335	2839	2514
	0.10	3127	1390	2611	2376
		(± 149)	(± 148)	(± 151)	(± 95)
	0.025	3179*	1744	3297	2740
	0.05	3146	1733	2854	2578
	0.075	3372	1523	3004	2633
	0.10	3046	1575	2717	2446
		(± 86)	(± 86)	(± 87)	(± 55)
	0.20	3176	1707	3008	2630
	0.30	3168	1599	3063	2610
	0.40	3212	1624	2831	2555
		(± 75)	(± 74)	(± 76)	(± 48)

* Means in columns within the table followed by the same letter(s) are not significantly different at the 0.05 level according to Duncan's new multiple range test.

Table 5

Effect of inter-row and intra-row spacing on the dry ribbon yield per plant (g)

Row spacing (m)	Plant spacing (m)	Season			Three-season average
		first	second	third	
0.20	0.025	2.43*	0.88	2.70	2.01
	0.05	3.78	1.96	2.88	2.87
	0.075	5.33	2.55	5.01	4.30
	0.10	6.25	3.21	5.87	5.11
0.30	0.025	4.25	1.31	4.15	3.23
	0.05	5.59	3.03	5.16	4.59
	0.075	8.36	3.28	6.96	6.20
	0.10	9.92	4.64	7.01	7.19
0.40	0.025	4.52	1.90	5.90	4.07
	0.05	7.91	3.82	5.77	5.83
	0.075	11.08	4.01	7.97	7.69
	0.10	13.05	5.30	8.89	9.08
		(± 0.47)	(± 0.47)	(± 0.46)	(± 0.29)
Plant spacing mean	0.025	3.73	1.36	4.22	3.10
	0.05	5.76	2.94	4.60	4.43
	0.075	8.26	3.28	6.65	6.06
	0.10	9.74	4.38	7.26	7.13
		(± 0.27)	(± 0.27)	(± 0.26)	(± 0.17)
Row spacing mean	0.20	4.45	2.15	4.11	3.57
	0.30	7.03	3.06	5.82	5.30
	0.40	9.14	3.76	7.11	6.67
		(± 0.21)	(± 0.23)	(± 0.23)	(± 0.14)

* Means in columns within the table followed by the same letter(s) are not significantly different at the 0.05 level according to Duncan's new multiple range test.

Plants from the 0.20 m row spacing produced more ribbon than those from plants spaced 0.30 and 0.40 m row apart (Table 6).

The 0.025 m within-row spacing gave the highest ribbon percentage among the four intra-row spacings; nevertheless the 0.05 m plant spacing produced significantly higher ribbon percentages than those from plants spaced at 0.10 m (Table 6).

The combined analysis for three years of data revealed that differences in ribbon percentages between the various row and intra-row spacings were not significant and no consistent trends could be discerned.

The interaction row spacing \times intra-row spacing was not significant in two out of three years or in the pooled analysis. The significance of the interaction in the third season was apparently caused by the inconsistent distribution of plant spacing means in the 0.20 and 0.30 m rows (Table 6). Correlation coefficients for all combinations of characters of yield and its components are presented in Table 7. Dry ribbon yield per ha was negatively and significantly correlated with plant height ($r = -0.65$) and with dry ribbon yield per plant ($r = -0.62$), whereas the work of SALIH (1978) gave a positive correlation.

The high significant positive correlation obtained between dry ribbon yield per ha and plant stand percentage ($r = +0.90$) indicated that yield potential was increased with a high plant stand percentage. SALIH (1978) reported a similar result.

The dry ribbon percentage in the plant was negatively associated with plant stand percentage ($r = -0.54$) and stem diameter ($r = -0.63$). Under close spacing the plants had higher ribbon percentages and smaller stem diameters. Plant height was significantly and positively correlated with ribbon percentage in the plant ($r = +0.75$) and with stem diameter ($r = +0.80$). It was negatively associated with plant stand percentage, as found by WILLIAMS (1966) and at variance with the observations of SALIH (1978), who reported that this association was positive but not significant ($r = +0.34$).

Regarding the correlation of plant height with dry ribbon yield per plant, the present investigation indicated a significant negative association ($r = -0.92$), whereas the work of HIGGINS—WHITE (1970) and SALIH (1978) gave positive but non-significant correlations.

The stem diameters and plant stand percentages showed significant and positive correlations with dry ribbon yield per plant. These findings are in accordance with those of SALIH

Table 6

Effect of inter-row and intra-row spacing on the percentage of dry ribbon to green weight in the stalk

Row spacing (m)	Plant spacing (m)	Season			Three-season average
		first	second	third	
0.20	0.025	5.95	6.57	7.88*	6.80
	0.05	6.02	6.86	7.68	6.85
	0.075	6.10	6.57	7.72	6.70
	0.10	6.13	6.34	7.76	6.74
0.30	0.025	6.03	6.85	7.84	6.91
	0.05	6.30	6.80	7.66	6.92
	0.075	6.31	7.05	7.52	6.96
	0.10	6.39	6.70	7.45	6.85
0.40	0.025	5.73	6.84	7.81	6.79
	0.05	6.19	6.72	7.75	6.89
	0.075	6.06	7.05	7.19	6.77
	0.10	6.18	6.80	6.65	6.54
		(± 0.16)	(± 0.25)	(± 0.15)	(± 0.10)
Plant spacing mean	0.025	5.90	7.75	7.84	6.83
	0.05	6.17	6.79	7.70	6.89
	0.075	6.16	6.89	7.48	6.81
	0.10	6.23	6.61	7.29	6.71
		(± 0.09)	(± 0.09)	(± 0.09)	(± 0.06)
Row spacing mean	0.20	6.05	6.58	7.76	6.77
	0.30	6.26	6.85	7.62	6.91
	0.40	6.04	6.85	7.35	6.75
		(± 0.08)	(± 0.08)	(± 0.08)	(± 0.05)

* Means in columns within the table followed by the same letter(s) are not significantly different at the 0.05 level according to Duncan's new multiple range test.

Table 7

Simple correlation coefficients (r) between dry ribbon yield
and five other characters in kenaf

	Ribbon yield per plant (g)	Ribbon yield, kg/ha	Plant stand, %	Plant height (cm)	Ribbon, %
Dry ribbon yield kg/ha	— .62*				
Plant stand percentage	— .77**	.90**			
Plant height (cm)	— .92**	— .65**	— .37		
Ribbon percentage	— .64**	— .19	— .54	— .75**	
Stem diameter (mm)	— .97**	— .12	— .80**	— .89**	— .63*

* Significant at the 0.05 level of probability.

** Significant at the 0.01 level of probability.

(1978). Stem diameter was negatively but not significantly related to the dry ribbon yield per ha ($r = -0.12$), whereas a positive correlation ($r = +0.17$) was obtained by SALIH (1978).

In spite of an approximately 800% increase in plant population from the closest to the widest spacing, the yields of the individual treatments were of the same order and no distinct trends could be discerned. Thus yield differences among individual plants compensated for a wide range of plant population.

Plant competition under higher plant populations is probably the major factor causing a reduction in dry ribbon yield per individual plant at the expense of the final yield per hectare. In very dense stands many plants are small and thin and tend to lodge badly near the end of the season. Many of these plants will be lost as waste material with the pith during the decorticating process (SALIH 1978). The blades of the decorticator are adjusted to a certain optimum stem thickness, so these thin plants will pass through the blades without being decorticated. In addition, the change in plant population at harvest from the original hand-thinned stand reached an approximately 35% loss of plants in the highest populations (HIGGINS—WHITE 1970). At lower plant populations the yield per individual plant contributed to the final yield and plant competition was perhaps largely avoided (SALIH 1978).

It is noteworthy that at increasing population levels invariably all yield components of the single plant, like plant height, dry ribbon yield per plant, ribbon percentage and stem diameter are in adverse association with those determining the per hectare yields. Thus, it seems that there is a balancing mechanism between the plant height, stem diameter, yield of dry ribbon per plant and ribbon percentage in the stem, which are the biological characteristics of the kenaf plant. So with different population densities an increase in one or two characters might occur, followed by a reduction in one or both of the other components, so the yield is not increased. Since the results of this study indicate that plant density affected stem size but not yield, intermediate densities of 667,000 and 500,000 plants/ha might be preferable for growing kenaf. A similar conclusion was reached by SALIH (1978).

This study was preliminary, so additional research is needed to study the effects and relationship of these various plant populations with sowing date, added fertilizer and uniform spacing of various plant populations on the dry ribbon yield.

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RESULTS OF RESISTANCE BREEDING ON ALFALFA

I. RESISTANCE TO FUSARIUM WILT

Infectious wilt caused by *Fusarium* spp. has spread all over the world and causes serious losses in alfalfa even under substantially different ecological conditions (BOLTON 1962).

Fusarium wilt in alfalfa was first described by WEIMER (1928), who established that the fungus causing wilt was *Fusarium oxysporum* var. *medicaginis*.

Many researchers from various countries have studied *Fusarium*-induced wilt and have dealt with the assessment of yield losses caused by it and the identification of the pathogen: McDONALD (1955) in Canada, O'ROURKE—MILLAR (1966), ARMSTRONG—ARMSTRONG (1965), FROSHEISER—BARNES (1978) in the United States of America, MARCLEY (1970) in Australia, ITTU—VARGA (1975) in Romania, CHI *et al.* (1964), CHI—CHILDERS (1966) and CHI (1968) in Canada, CSUTI (1963), BÖJTÖS *et al.* (1969) and MESTERHÁZY—MANNINGER (1972) in Hungary.

No resounding success can be expected from the chemical control of *Fusarium* wilt in alfalfa. Therefore, selection for resistance and an increase in the frequency of the resistant gene in the existing high yielding varieties forms one of the main objectives of breeding.

The possibility and necessity of breeding for resistance have been raised by a number of authors, including BÖJTÖS *et al.* (1969), MANNINGER (1973, 1978), MANNINGER—MALATIN (1975) and TÓTH—KOVÁCS (1978) in Hungary, but the reports on breeding results are mostly of a general nature. Numerical experimental data were supplied by WILSON—MELTON (1962) who successfully increased the resistance of alfalfa to *Fusarium* by recurrent selection.

FROSHEISER—BARNES (1976) inoculated 71 varieties and 10 lines of alfalfa with *Fusarium oxysporum*. When evaluating the results they found that 12 weeks after the inoculation the degree of infection, which shows the wilting response of the varieties, ranged between 1.73 and 4.78 (1 = healthy, 5 = destroyed plant), while the number of plants destroyed ranged between 13 and 92% depending on the variety.

The possibility of increasing the resistance level was also proved by a test in which the degree of infection of the progeny derived by intercrossing perfectly healthy plants selected from the alfalfa variety MnPL5 was found to be 2.26 compared to 3.93 in the initial material. The proportion of plants destroyed was 68% in the initial material and 33% after one cycle. FROSHEISER—BARNES (1978) consider that at present there is no standard method available which could be successfully used to select a large number of resistant plants.

Two Hungarian alfalfa varieties were chosen for the examination. One of them was Tápíószelei-1, a synthesized selection of French, American, Soviet and Hungarian varieties, given state certification in 1970; the other was Szarvasi-2, produced by the synthesis of Hungarian resistant field strains and given state certification in 1978.

Selection for resistance was carried out in two cycles with both alfalfa varieties. In the first cycle seedlings were artificially inoculated with *Fusarium* suspension in a greenhouse. The *Fusarium* culture was isolated from the roots and stalks of alfalfa plants showing signs of infection.

The culture was kept in a Petri dish with Czapek culture medium. For inoculation a suspension containing 7—10 million spores per ml was prepared from the pure strain and the liquid culture medium. To achieve optimum germination the seeds were germinated on filter paper placed on a wire net over a layer of water 1.5 cm deep in an 85×55×15 cm plastic tray (Fig. 1). In order to maintain the required level of humidity the tray was covered with plastic film. A permanent optimum moisture was ensured by immersing only the edges of the filter paper in the water. After a week a radicle with an average length of 20 mm developed. Then the seedlings were carefully removed from the filter paper with a pair of pincers, the tips of the radicles were cut with scissors, and the radicles were dipped in the suspension. The seedlings were placed in plastic dishes 15 cm in diameter, with 100 seedlings in each dish.

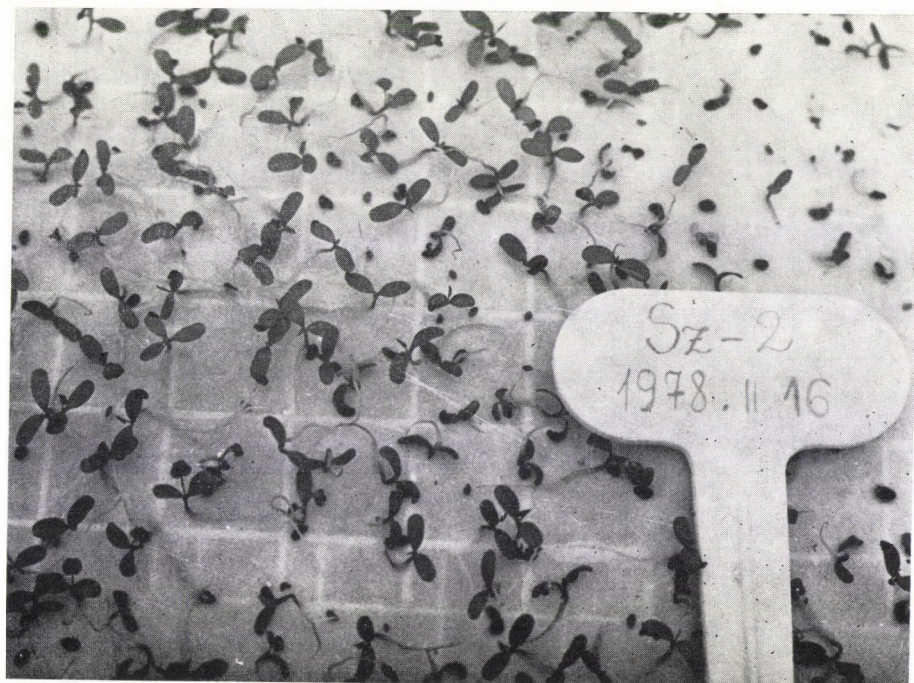


Fig. 1. Raising seedlings for inoculation

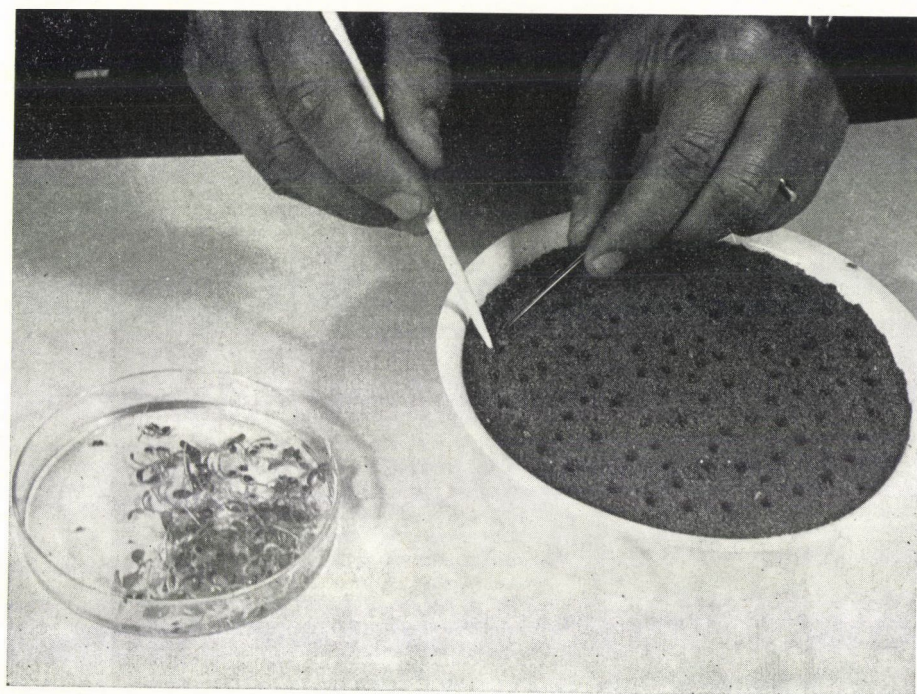


Fig. 2. Transplantation of inoculated seedlings

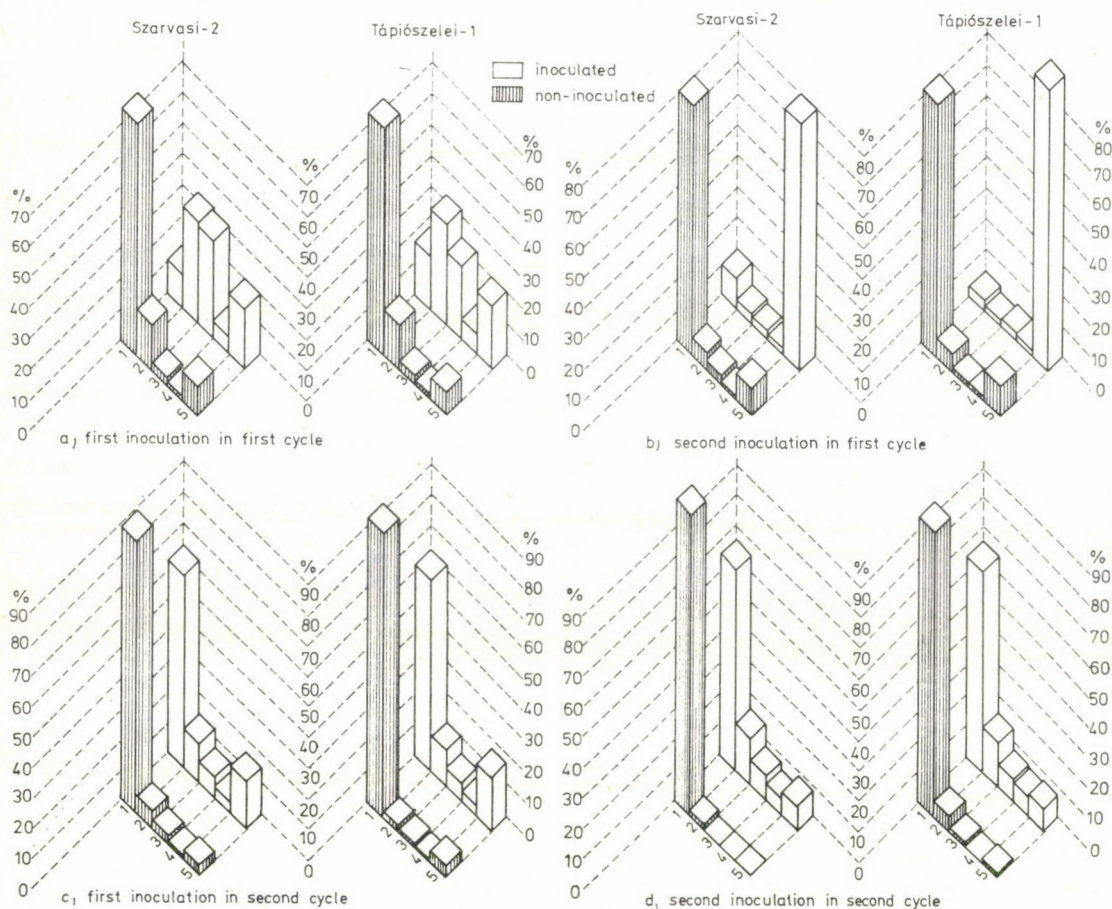


Fig. 3. Relative numbers of plants of different grades in the selection cycles

The dishes were filled with 550 g Danube sand mixed with 60 ml suspension (Fig. 2). The seedlings were raised in a greenhouse at a temperature of 25–28°C. The experiment was evaluated a month after transplantation. The numbers of healthy, diseased and destroyed plants were recorded, then the plants were graded from 1 to 5 according to the degree of infection. (1 = no sign of infection, 2 = slight yellowish discoloration and one or two rolled leaves, 3 = more intensive yellowish colour, leaves rolled, shrivelled and beginning to wither, 4 = nearly all leaves rolled and withered, 5 = seedlings destroyed.)

On the basis of the above grading the degree of infection (D) was determined by the following formula:

$$D = (1f_1 + 2f_2 + 3f_3 + 4f_4 + 5f_5) \sum F$$

where 1...5 indicate the grades, $f_1 \dots f_5$ the number of plants belonging to the respective grades, $\sum F = (f_1 + \dots + f_5)$, i.e. the total number of plants.

Plants belonging to grades 1 and 2, which were regarded as resistant, were removed after the evaluation and their roots were washed clean in water; then, after the root tips had been cut, they were placed in the suspension for 24 hours for the purpose of repeated infection. After that they were planted in propagation boxes containing 10 kg soil mixed with 500 ml suspension. Seven weeks after the transplantation the plants were evaluated and graded on the basis of the symptoms shown.

Table 1

Degree of infection of the alfalfa varieties examined in the two selection cycles

		Number of treated plants		Degree of infection	
		Tápiószelei-1	Szarvasi-2	Tápiószelei-1	Szarvasi-2
First cycle of selection	<i>A month after the first inoculation</i>				
	Inoculated	3000	3000	2.815	2.908
	Control	700	700	1.550	1.560
	LSD 5%			0.178	0.167
	LSD 1%			0.236	0.222
	<i>Seven weeks after the second inoculation</i>				
	Inoculated	1473	1295	4.796	4.403
	Control	571	525	1.507	1.511
	LSD 5%			0.295	0.292
	LSD 1%			0.402	0.397
Second cycle of selection	<i>A month after the first inoculation</i>				
	Inoculated	1800	2000	2.008	1.905
	Control	600	600	1.215	1.219
	LSD 5%			0.306	0.355
	LSD 1%			0.409	0.476
	<i>Seven weeks after the second inoculation</i>				
	Inoculated	1285	1462	1.746	1.760
	Control	480	364	1.107	1.016
	LSD 5%			0.194	0.339
	LSD 1%			0.264	0.460

LSD 5% = 0.204, LSD 1% = 0.277.

The degree of infection was calculated in the manner described above. Controls were set up from both varieties in addition to the inoculated treatments in each case. In order to prevent the infection of the control seedlings, their transplantation always preceded that of the infected plants. Field trials were again laid out with plants belonging to grades 1 and 2 only; the soil of the trial grounds was highly infected with *Fusarium*.

During the second growth in the nursery the healthiest plants were selected from both varieties, and intercrossing was carried out according to varieties and treatments under tulle covers with the help of honey-bees.

In the second cycle seeds obtained in the first cycle were germinated, and the seedlings were inoculated as described above.

The relative number of plants graded according to the extent of wilting is shown in Fig. 3.

As seen from the data, grade 1 (healthy plants) included less inoculated plants than control plants. The opposite tendency is found in grades 2, 3, 4 and 5.

The data obtained in the inoculated and control treatments in the first and second cycle are summed up in Table 1.

The data in the table reveal a highly significant difference in the degree of infection between the inoculated and control seedlings for both varieties on each occasion of inoculation, though this difference was greatly reduced in the second cycle of selection in both cases.

In the course of selection in the variety Tápiószelei-1 the degree of infection in the first and second cycles was 4.796 and 1.746 for the inoculated, and 1.507 and 1.107 for the control plants, respectively, after the second infection. In the same treatments the corresponding values for the variety Szarvasi-2 were 4.403 and 1.760; and 1.511 and 1.016, respectively. In the first cycle the degree of infection after the second inoculation was higher than after the first one. The reason is that in grades 1 and 2 73% of the Szarvasi-2 plants and 66% of the Tápiószelei-1 plants already showed signs of infection at the time of the second inoculation. The responses of the two varieties examined to infection by *Fusarium* species are shown by the data in Table 2.

A comparison of the data reveals a substantial difference between the degrees of infection in the two selection cycles. The level of resistance is indicated by the number of plants placed in grades 1 and 2, which were considered to be practically resistant.

The total number of healthy, diseased and destroyed plants adds up to 100%.

The data prove that the selection was efficient, the resistance level of the varieties rose, and the number of infected and destroyed plants decreased. The percentage resistance in the variety Szarvasi-2 after the first inoculation was 43.17; the proportions of healthy, diseased and destroyed plants were 10.83, 69.33 and 19.84%, respectively.

In the second cycle the relative numbers of plants belonging to the different groups were 75.25, 62.90, 22.10 and 15%, respectively.

The results show that the tendency was the same for the variety Tápiószelei-1. It is also clearly seen from the data in the table that after the second inoculation in the first cycle the percentage of plants showing symptoms of infection was lower than after the second inoculation in the second cycle. This can be attributed to the high proportion of plants destroyed in both varieties after the second inoculation in the first cycle. In the variety Tápiószelei-1, 92% of the plants were killed, and the remaining 8% was distributed among the four grades. A similar phenomenon was observed in the variety Szarvasi-2, in which 80.55% of the plants perished after the second inoculation in the first cycle.

The number of resistant plants in the first and second cycle of selection increased in both varieties after the first and second inoculation alike. The frequency of resistant plants grew from 5.84 to 60% in the variety Szarvasi-2, and from 2.02 to 59.44% in Tápiószelei-1. These results agree with those obtained by WILSON—MELTON (1962) and FROSHEISER—BARNES (1976).

Plants with a high level of resistance, which were found in both varieties examined, prove that the selection increased the number of resistant genes, and that new genotypes which were not present in the initial material were produced through recombination.

The experimental results show the probability that resistance is controlled by a small number of genes, which is why it proved possible to raise the resistance levels of the two alfalfa varieties to a considerable extent in a relatively short time.

Table 2

Effect of selection on the level of resistance in the alfalfa varieties examined

Variety	Treatment	Cycle of selection	Extent of infection	Resistance	Healthy	Diseased	Killed
				%			
Szarvasi-2	First inoculation	first	2.908	43.17	10.83	69.33	19.84
		second	1.952	75.25	62.90	22.10	15.00
	LSD 5% LSD 1%		0.149 0.198	5.09 6.73	4.60 6.08	3.60 4.75	3.13 4.14
Szarvasi-2	Second inoculation	first	4.403	13.51	9.97	9.48	80.55
		second	1.760	79.74	64.63	27.65	7.72
	LSD 5% LSD 1%		0.230 0.306	7.88 10.42	7.12 9.42		4.85 6.42
Tápiószelei-1	First inoculation	first	2.815	49.27	16.93	62.37	20.70
		second	2.008	74.39	62.50	19.89	17.61
	LSD 5% LSD 1%		0.154 0.204	5.25 6.95	4.75 6.28	3.71 4.90	3.23 4.28
Tápiószelei-1	Second inoculation	first	4.797	4.09	2.73	4.88	92.39
		second	1.745	79.90	65.57	27.29	7.14
	LSD 5% LSD 1%		0.244 0.323	8.30 10.99	7.50 9.93		5.11 6.76

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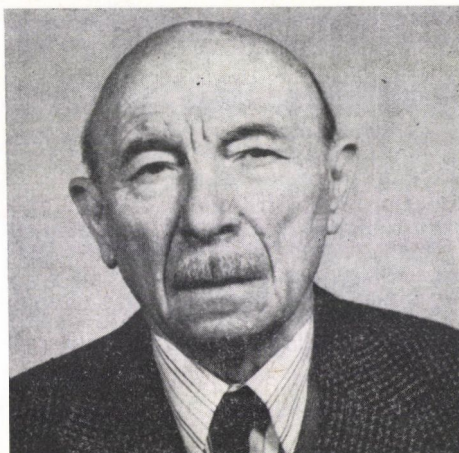
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FORUM

OUR GUEST IS



MR. FERENC DONÁTH

FORMER UNDER-SECRETARY OF STATE AT THE MINISTRY OF AGRICULTURE,
HUNGARY (NOVEMBER 1945—DECEMBER 1947)

PÁL, GY.: Sir,

Ignác Darányi elaborated two proposals on land policies in 1903 and 1909, respectively, on the basis of the Land Policy Conference organized in January 1900, but unfortunately these were never incorporated in law. The Land Law of 1920 (Act XXXVI) produced new landed properties which, since the average area was 1 ha, further increased the already large number of dwarf-holdings. In accordance with the principle of real inheritance in effect at that time even the existing small-holdings began to break up into dwarf-holdings. In your opinion, why was it that the obviously viable 5—50 ha peasant farms did not become dominant in the land distribution system?

DONÁTH, F.: For the 5—50 ha peasant farms to become dominant, the existing system of land distribution would have to have been considerably changed, at the expense of landed properties of over 50 ha. However, the Hungarian landed gentry refused any attempt to reduce its lands. This class ruled the country until 1945, even though the power was not exclusively in their hands. Owners (tenants) of estates larger than 57 ha, who numbered some 7.5 thousand, made up around 40,000 people together with their families between the two world wars. But nearly half (4.27 million ha) of the total cultivated area was in their hands. All important posts were occupied or disposed of by this class. They not only controlled the army and other armed groups, but also had their way in public administration and legislation; the Upper House of Parliament

(the former Table of Magnates) was mostly composed of members of this class. They even had influence on people's souls, since the Catholic Church was the biggest landowner in the country, owning more than 570,000 ha of land, which was thus withdrawn from circulation.

The peasant landowners, on the other hand, were neither strong enough, nor represented an independent political force. Even in the period between the two world wars no-one of peasant origin could become an officer or enter the upper ranks of public administration. In order to win the favour of the peasantry peasants were, in fact, made ministers on two occasions in the critical period following the Great war, but even they had no actual power. The word "peasant" had a pejorative meaning.

The landed peasantry was not an independent force either insocio-economic or in political life. Respect for the gentry and fear of the agrarian proletariat were so strong in this stratum that, with the exception of the party led by András Áchim, its organizations were all under the leadership, or at least under the influence, of the landed gentry. In crucial issues they followed the lead of the big landowners even if differences arose between them.

The other force opposed to the landed gentry was represented by the village poor. Approximately half of the population lived from agriculture; together with their families they numbered 4.5 million people. About two-thirds of this wide social layer were either landless agricultural labourers and farm servants, or owners of plots of less than 1/2 ha or between 1/2 and 3 ha. The political parties and other organizations that demanded the radical redistribution of the large estates recruited the majority of their members from among their ranks. The differences between them and the big landowners was the main source of social tension.

The fact that the owners of farms between 5 and 50 ha in size were generally short of capital, and that their farming practices and views were backward acted against the dominance of such farms. In addition, the rules of inheritance reduced the size of these farms.

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PÁL, Gy.: *In 1935 dwarf-holdings of less than 2.5 ha represented 74.7% of the total number of landed properties in Hungary, but only 10% of the total area; large estates of over 250 ha made up only 0.15% of the number of landed properties, but took up 37.7% of the total area; the number of peasant holdings between 5 and 50 ha was 15% of all landed properties and occupied 30% of the agricultural area. The Entail Law (Act XI/1936), one paragraph of which dealt with entailed small-holdings, the so-called peasant entail, was intended to promote a sounder system of land distribution. Why, in your opinion, did this peasant entail not meet with the approval of the peasantry in Hungary?*

DONÁTH, F.: The provisions of the Entail Law, which made it possible to establish peasant entails, followed a foreign (German) model and was alien to the mentality of the Hungarian peasantry. Their sense of law refused to make a distinction between their children in financial matters. In their eyes land gave them a living, but at the same time it was the solid basis of social rank and respect in the villages. The value of the landed property was increased by the difficulty of improving their social position as well as by the economic crisis. Characteristically of their way of thinking, old Hungarian civil law subjected any distinctions made between children in the case of inheritance to stringent conditions.

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PÁL, GY.: *It is a well-known fact that masses of landless people chose to go abroad, mainly to the United States of America, to do hard physical work, to work in mines and industries, in order to save money and then return to their villages and buy a little land, rather than move to another region of Hungary and settle down there. Any attempt at resettlement (such as that of vine-growers from Transdanubia to Transylvania, or of landless peasants from the Jász-Nagykun-Szolnok region, between the rivers Danube and Tisza, to Transdanubia) turned out to be a failure. What do you consider to be the reasons for this?*

DONÁTH, F.: Spiritual and existential reasons both played some role in the villagers resistance to leaving their native villages and settling down in another part of the country. The very thought of being separated for ever from relatives, friends, neighbours, and even from the scenery, which was filled with memories, was painful for them. They considered that migrants lost their pasts, since the past survives in man through familiar scenes and faces. Those who emigrated to overseas countries boarded the ship with the intention of returning and buying houses and land in their home villages.

Many were kept back by a feeling of uncertainty. Would they have enough strength and financial means to build a new home and establish a new farm? Often even those who applied for resettlement stood down when shown the place assigned for the establishment of the new village. The resettlement carried out on the basis of Act VI/1945 and Act IX/1946, though not devoid of various difficulties and troubles, especially in villages and farms abandoned by Germans expatriated in consequence of the Potsdam agreement, was more successful than earlier resettlements, since it imposed much less of a burden on the settlers. Yet some success was achieved before 1945 too, though the resettlement then was of limited extent.

Resettlement connected with the land reform of 1945 can be divided into two large groups.

I. On the former large estates, 19 new villages and 14 small settlements were established. The total area allotted was 71,000 ha, and the number of people granted land was 10,265, which was quite a large number considering the history of Hungarian settlements. However, this number included very few families resettled from other regions: a mere 8% (794 families). The settlers were mostly former farm servants from large estates. A slightly lower number of settlers were local residents with justifiable claims for land. The proportion of families resettled from neighbouring villages was smaller. In the settlements the size of the allotments was larger: an average of 4.5 ha compared to a national average of 2.8 ha.

II. The repatriated Germans were replaced by approximately 25,000 rightful land claimants. The average size of the allotments was only slightly smaller than in the case of those settled on large estates.

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PÁL, GY.: *The agricultural price gap, indicating the difference between industrial and agricultural price levels, meant a curtailment of agricultural origin of at least 40–50% in 1946–47, depending on the basis for calculation; it was only during 1947–48 that the price gap began to close. In spite of this the peasantry was more willing to invest and produce than before the war, so private agricultural investments in 1946–47 already exceeded by far the 1938–39 level; i.e. despite a 40% reduction in income (amounting to 8 thousand million Ft in 1938–39 and only 4.8 thousand million Ft in 1946–47) the accumulation of capital rose by 26% (from 163 to 206 million Ft). Why and how do you think this happened?*

DONÁTH, F.: It will be better to ignore the numerical data on both the price gap and the agricultural investments. Many objections can be raised to the way these calculations were

made during the years in question. It is a fact, however, that at the beginning of the stabilization which followed inflation the agricultural price gap opened in comparison to the prewar years (1938). And it is also a fact that Hungarian agriculture developed at a very fast rate in spite of its enormous war losses: only about 40% of the horse and cattle stocks were left, and even these were in a rather poor state; the pig and poultry stocks suffered still greater losses; the damage done to the farm buildings and implements, both on large estates and small-holdings, was considerable. Even the severe drought and the shortage of credit and assets in 1946 and 1947 did not prevent agricultural production from progressing. By 1949 the gross and net production value of small-peasant agriculture had reached 90% of the average production value between 1934 and 1938.

If the uncertainty concerning proprietary rights which inevitably accompanied the execution of the land reform and which unfavourably influenced farming and investment activities is also taken into consideration, the question rightly arises: how did it happen that under such unfavourable conditions the peasant agriculture achieved such good results within a few years?

The main source of success was the hard-working character of the peasants, since manual work played a decisive role in farming at that time. Production was carried out using traditional methods and there were fewer technical and financial means available than during the prewar period.

Success also had its source in the desire of a wide social stratum, oppressed for centuries, to improve their social position. This encouraged hundreds of thousands to make almost unimaginable efforts.

The peasants were also animated by their faith in the democratic order that carried out the land reform and ensured their political rights. Democracy provided wide-ranging opportunities for them to rise as small-landowners both economically and socially. Their faith in the future was a subjective source of strength which often made up for shortages in the material means of production.

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PÁL, GY.: *The land reform of 1945 was an achievement of the bourgeois democratic revolution; it abolished feudal-capitalism in Hungary and eliminated the class of big and medium landowners. A total area of 3,212,553.6 ha was expropriated, of which 1,899,004.8 ha was distributed among 642,000 rightful claimants. In spite of the fact that this land passed into private ownership the land reform did not strengthen capitalism but promoted the transition to socialism instead. Do you think that the small-holdings produced by the land reform would have remained pillars of socialism after they had strengthened economically?*

DONÁTH, F.: The question can only be answered theoretically, since the historical development does not give any clue to a direct answer. No social stratum will support the system if the latter does not lead to an improvement in its financial and social standing. This was the case in 1953 and 1956 in Hungary, when those who had been granted land left the co-operatives en masse. And in Poland, despite the fact that collectivization was not enforced, the peasants who had received land did not back the system, either in 1980 or before or after that date. However, negative conclusions cannot be drawn from these experiences alone. It is worth mentioning one form of farming co-operation to which sufficient importance was not, unfortunately, attached. In this specialized form of co-operative the members of the association established a large-scale co-operative farm while maintaining private ownership and management.

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PÁL, GY.: *Decree No. 600/1945. M.E., passed by the Provisory National Government, and presented by you at the 6th meeting of the Provisory National Assembly on 11th September 1945, made provisions for the abolition of the large estate system and for the allotment of land to the agricultural population. Paragraph 15 of this government decree states: "Landed properties of up to 300 cad. yoke (162.6 ha) owned by those who gained distinction in the national resistance movement or in the war of independence from the Germans are exempted from expropriation". What, to your knowledge, happened to these lands later, when their owners, branded as class-aliens, were prevented from joining the co-operative movement?*

DONÁTH, F.: I am not acquainted with the later fate of farms which were granted for participation in the resistance movement. Their owners probably did the same as everyone for whom farming in the early fifties became practically impossible: they handed over their land to the state.

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PÁL, GY.: *The redistribution of land not only drew new production forces into farming, but also destroyed a considerable production force due to the liquidation of the large-scale farms. You wrote the following: "... if the land reform had been carried out under somewhat more favourable economic and social conditions, the abolition of the large estate system would not have involved the total annihilation of the large-scale framework of production". When the co-operative farms were established a similarly important — though this time a small-scale — production force was destroyed. Do you think it was wise to try to stop small-scale production completely when abolishing the small-holding system and establishing co-operative farms?*

DONÁTH, F.: It was not wise either in industry or in agriculture. The idea that small farms were a model of technical backwardness and a social power endangering socialism completely ignored the actual conditions and did nothing to fulfil the social requirements. The state attempted to provide every kind of service and produce all goods and spare parts on a large scale. The consequences are well-known. 1. There has been a constant shortage of important goods; the personal requirements of the population and important production needs have been left unfulfilled. 2. The large-scale provision of certain goods and services has proved to be much more expensive, if not impossible, than when the tasks are performed in small units.

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PÁL, GY.: *Those members of co-operative farms who, because of their age, did not qualify for a pension, receive a monthly allowance. This amounted to 260 Ft when the co-operative farms were established, and is now 1300 Ft. At the time when the co-operative farms were organized these workers were still able to work on their homeplots; today they are helpless. The pension of a co-operative farm worker is now 1900 Ft, while the pension of other workers is 2800 Ft on average. Today this allowance, granted to founder members of the co-operatives, on whose land the farms were established, amounts to less than half of a worker's pension. Do you think the 260 Ft allowance given to co-operative farm members who were still more or less capable of working or the 1300 Ft now received by these disabled people represents the higher standard of living?*

DONÁTH, F.: I think the main point is that the allowance granted to co-operative farm members both in the past but particularly at present, is extremely low. And the co-operative farm pensioner is still at a disadvantage compared to the retired industrial worker, although the difference has gradually been reduced since 1975. But the main trouble

is that the real value of any pension, whether given to physical or intellectual workers in any branch of the national economy, is not only low, but is decreasing from year to year. The officially admitted annual decrease in the purchasing power of money is two to three times the annual 2—3% increase in pensions; and the actual degree of inflation is higher than that.

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PÁL, GY.: *Ingersoll writes: "Military exercises took place to a limited extent and seldom, because on such occasions the troops had to march through the farmers' lands, and it was the Minister of Agriculture rather than the War Minister who decided what should happen on the fields of England in the spring of 1943". Although the government knew only too well that the opening up of the second front required preparations involving superhuman efforts, it still attached such importance to agricultural production. Why is it, in your opinion, that in the Hungarian People's Republic the share of agriculture in the total investments has dropped from 19% in 1970 to 11.7% in 1980, showing an opposite trend?*

DONÁTH, F.: Since the growth rate of the national income first decreased, and has recently at best stagnated, it was inevitable that investments should be reduced throughout the entire national economy. It is decidedly unfavourable that the reduction in investments is of much greater extent in agriculture than in other branches of the national economy. The disadvantages of this fact are felt most strongly in the large-scale farms, and will be increasingly felt in the years to come. The problem of agricultural investments is, however, more complex than just their share in the total investments or the extent of investment, and a solution will be difficult to find.

1. Some of the investments do not serve to expand production, but merely replace the resources lost due to the withdrawal of land from production and the decrease in the labour force. 2. The expensive machinery and materials needed to replace the labour force which migrates away from agriculture, though this has decreased in recent years, constantly increases the production costs. 3. The farms are not sufficiently self-reliant in determining the trend of development, and this often has an unfavourable long-term influence on farming efficiency. 4. The costs of production are increased and the efficiency of investments decreased by the lack of choice; the machinery, in particular, often does not meet the requirements of the farms.

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PÁL, GY.: *In the USA the price of the farm equipment used in plant production has risen to 258% and that of plant products to 215% over the last ten years, while the crop production level has risen to 134%. In Hungary the trends in the price of farm equipment and the production level have been similar to those in the USA, but the increase in the prices of animal and plant products in Hungary has fallen far behind that in the USA. The disparity in price between the basic farm products and agricultural equipment is increasing from year to year. What do you think will be the consequence of this?*

DONÁTH, F.: The general effect will be a continued decrease in the net incomes of the farms. The farms will consequently be less and less interested in developing production, or at least in producing certain goods. If the agricultural price gap reaches the point where it has an adverse influence on the personal incomes of the workers, the migration of the labour force will become more intensive again, and the differentiation of the farms, which is already in progress, will be accelerated.

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PÁL, GY.: *Thank you for your information.*

CHRONICA

THE AGRICULTURE OF THE MEZŐFÖLD REGION IN 1928-1937

1. The Mezőföld as a regional unit, and its general characteristics

The Mezőföld is a geologically and geographically well definable regional unit of Transdanubia, the western part of Hungary. It is bordered in the north-east and north by a sunken hill ridge at Érd, the valley and the upper reaches of the Benta, a stream flowing into the Danube, and the valley of the Sajgó stream; in the north-west by the edge of the Vértes and Bakony hills, as far as Fűzfő bay, which forms the north-eastern corner of Lake Balaton; in the west by the shore of Lake Balaton between Balatonfűzfő and Siófok; in the south by the tectonic erosion valley of the Sió Canal as far as Simontornya, and from then on by the terrace field stretching to Dunaszentgyörgy; and finally in the east, by the steep bench forming the western bank of the Danube (ÁDÁM *et al.* 1959). The regional unit measures 124 km in a north-south and 70 km in an east-west direction; excluding the Velence hills, which form an island in the region, the Mezőföld has an area of 4500 km². The regional unit has an average altitude of 120-180 m above sea level, and consists of plains and sloping hills; its Pannonian layers are thickly covered by loess (to a depth of 50 m at Paks, for example). The regional unit is divided largely from north-north-west to south-south-east by the Gaja and Sárvíz valley into a smaller western and a larger eastern part. The valley, about 70 km long, is characterized by vast meadows and peat fields (ANONYMOUS 1961).

From 1928-1937, as an administrative district the Mezőföld belonged mostly to Fejér County and to a smaller extent to the counties of Veszprém and Tolna, unlike the present situation, which has been in effect since 1950, whereby the Mezőföld belongs almost fully to Fejér County, except for the south-eastern corner which comes under the administration of Tolna County.

2. Land distribution in the Mezőföld between 1928 and 1937

After the 1920 Paris Peace Treaty (concluded in the Trianon palace at Versailles) only the central, densely inhabited parts of the country were left in the possession of the Hungarian Kingdom. The size of the population per square kilometre increased to 82, twice the average population density of Europe. (M.S.Sz. 1923, 289-290; Magyar Statisztikai Szemle = Hungarian Statistical Review, henceforth abbreviated H.S.R.) A serious problem was caused by the fact that the high population density, which was as high as 92 in some regions, e.g. in Zala County, was primarily characteristic of only moderately fertile areas of the country. At the same time in the Mezőföld, one of the best agricultural areas of Hungary, the size of the population per sq. km. was remarkably low. In Fejér County, where the largest part of the Mezőföld belonged (4008 sq. km with a population of 223,000 in 1920) the density was 66 inhabitants per sq. km, but on the area under agricultural cultivation (412,216 ha) this number was only 56. That is, the richest agricultural area was the most thinly populated region of the country! This can be explained by the fact that the highest number of large estates above 58 ha were found in this region of the country. While the proportion of large estates was 28% on a national scale and 38% on average in Transdanubia, in the Fejér County area of the Mezőföld this proportion was as high as 69%. This meant that of the 398,144 ha agricultural area of Fejér County, 276,413 ha were in the hands of the big landowners (H.S.R. 1938, 266).

The problem of overpopulation in Hungary could only have been solved by industrialization or resettling, combined with a partial land reform. Since the capital required for the

former was not available, the latter remained the only solution. This resettlement to normalize the population density and the land allocation it necessitated was primarily intended for implementation on the thinly populated, fertile area of Fejér County. Economists who wished to protect the large-scale farms on the big estates were against this plan. In their opinion, having lost its traditionally industrial areas, Hungary could only export agricultural products. The export demands could not have been satisfied by small-holdings; only large-scale capitalist agriculture was capable of doing so. The manager of the 17,000 ha estate of the Cistercian Abbey at Zirc, the largest landed property in the Mezőföld, advanced the following argument: "... If it were distributed among some 2000 families, the estate would provide a lower income for each, not to mention the complete deterioration of domestic (Budapest) and foreign export quality. The foreign currency requirements of the country would reach catastrophic proportions. To take over the well-equipped large estates and break them up into 6—8 ha plots would be equal to national suicide. It is self-evident, at the same time, that the large estates should shoulder the responsibility of the social burdens."¹

However, after the downfall of the Austro-Hungarian Empire in 1920, which had ensured a constant, safe outlet for Hungarian exports, the agricultural exports, which were of vital importance for the country, declined from year to year. The former member countries of the Empire (Austria, Czechoslovakia, Romania and various parts of Yugoslavia) either wished to protect their own agricultural production or had the choice of importing agricultural products from Hungary of (often at much lower prices!) from other countries. Owing to its relatively high production costs, Hungarian agriculture gradually lost its competitiveness compared with countries which produced goods at lower costs and sold them at lower prices (the United States of America, Canada, the Soviet Union, etc.). By the end of the twenties the world market prices for agricultural goods reached a minimum, at which point the expensive Hungarian agricultural products became unsaleable on the international markets.

The government tried to overcome this critical situation with a partial land reform, decreed on 20th June 1921 by the Court of Land Redistribution on the basis of Acts XXXVI (1920) and VII(1924). The execution of the land reform was necessitated by the critical political situation as well. After the proletarian revolution in 1919, the government hoped to win the favour of the peasantry and, by reducing the number of agricultural proletarians, to increase the size of the peasant society which was interested in the protection of private property. Land distribution was made urgently necessary by the intensive unionization of the agricultural labourers. The National Headquarters of the Independent Union of Agricultural Labourers, established at that time, gradually became leftist under the influence of infiltrated illegal communists, and spread propaganda for the distribution of the big estates, particularly of church lands. The execution of the land reform was an extremely slow process. The first allocations were made from entailed properties, which were designed to preserve the former feudal large estates. In Fejér County the entailed estates underwent the following changes during the land reform: in 1920 the total area of entailed lands was 37,183 ha, including 19,327 ha of arable land, while in 1930 the total area of entailed lands was 28,496 ha, including 11,902 ha of arable land.

In the course of the land reform the entailed estates gave up a total area of 4775 ha, of which 4413 ha was arable land (H.S.R. 1931, 1015).

The distribution of the land bought by the state from the land-owners and allotted to claimants who paid for it in instalments was completed by the end of 1931. In Fejér County 30,170 ha of land were distributed altogether, of which 5950 ha (531 plots) were given to soldiers who had distinguished themselves in the Great War. The rest (24,220 ha) was distributed among 24,710 claimants, 70% of whom were landless agricultural labourers. Thus, each family received barely one hectare of land (FARKAS 1970a).

The land reform did not bring about much change in the land distribution of the Mezőföld. In the Fejér County districts of the Mezőföld 72 large estates remained with an area of 300—600 ha each, and 91 with more than 600 ha of land. These 163 large estates occupied more than 60% of the agricultural area of the county (H.S.R. 1928). At the same time the number of unviable dwarf-holdings increased enormously. In the years following the land reform the following proportions of holdings were found in Fejér County:

dwarf-holdings:	80% of the total number of holdings; 54,291 dwarf-holdings occupying 40,835 ha, i.e. 13% of the total area;
small-holdings:	18% of the total number of holdings; 14,438 small-holdings occupying 122,450 ha, i.e. 41.5% of the total area;

¹ Veszprém County Archives. Documents of the Cistercian Abbey of Zirc. Secretary's report for 1931—1932. IV. Economic affairs, 35. Hereafter: VCA, Zirc Abbey documents.

medium estates: 0.7% of the total number of holdings; 385 medium estates occupying 71,700 ha, i.e. 10.5% of the total area;
 large estates 0.2% of the total number of landed properties; 91 large estates occupying (landed properties of over 600 ha) 184,750 ha, i.e. 35% of the total area.
 (H.S.R. 1938, 266)

The property distribution differed from the national average:

- there were more large estates of over 600 ha (of which the Előszállás and Hercegfalva estates of the Cistercian Abbey at Zirc together covered more than 15,300 ha) than in other parts of Hungary on average;
- the average area of medium estates was also 19.2% larger than the national average;
- the average size of small and dwarf-holdings, on the other hand, was below the national average.

The size of the population in Fejér County, together with the administratively independent town of Székesfehérvár, was 270,714 in 1930, of whom 40,714 were inhabitants of Székesfehérvár. 73% of the people in the county and 18% of the inhabitants of Székesfehérvár (a total of 167,246 people) made a living from agriculture.

One-third of those employed in agriculture belonged to the agricultural proletariat even after the land reform:

— landless contracted agricultural labourers (farm-hands)	13,159 earners, making up 39,792 people with their families;
— landless agricultural seasonal workers (day-workers)	18,632 earners, making up 41,980 people with their families;
— dwarf-holders with 0.5—2.5 ha, who undertook seasonal work on other estates	25,425 earners, making up 45,569 people with their families;
— small-holders and medium landowners with	
2.5— 5.5 ha	359 earners
5.5—11.0 ha	13,551 earners
11.0—28.0 ha	5,742 earners
28.0—55.0 ha	752 earners.

As regards living standards, the agricultural seasonal workers (day-workers), the dwarf-holders and the small farmers with 2.5—5.5 ha were in the worst position. Agricultural labourers who were paid in kind under contract on large estates (farm-hands) were relatively better-off. Their yearly contracts ensured a safer basis of existence for themselves and their families. The manager of the 15,300 ha estate of the Cistercian Abbey at Zirc, the largest landed property in the Mezőföld, emphasized the importance of this fact in his summarizing report for 1931—1932. According to this report 750 families worked on the estate, of whom the wage-earners included: 1130 agricultural labourers working under one-year contracts (farm-hands), 41 gardeners (tobacco growers), 72 technical staff (mechanics, millers, craftsmen), 21 officials, 9 teachers, 12 retired officials and 108 retired servants. (Together with their families they totalled about 4000.) Paying them in kind meant an annual expense for the estate of 53 wagons of wheat (about one-sixth of the 1931 crop), 67 wagons of rye (about half of the 1931 crop) and 34 wagons of barley (about half of the 1931 crop). The estate rented out 1436 ha of land, on which it carried out the ploughing, sowing and harvesting, and supplied feed for 1500 cows and 4500—5000 pigs owned by the farming families. To sum up: of its total annual income of 2,755,000 pengős (1931) the estate paid the contracted agricultural labourers 136,292 pengős in cash and 895,831 pengős in kind.

When broken down by families, the estate made the following annual payments: 145 pengős in cash, plus 7 q of wheat, 9 q of rye and 4.5 q of barley; also, the expense of keeping 2 cows and 6 pigs and the use of 1.5 ha of arable land. This meant a total value of 850—1000 pengős per family a year, which was free of all rates and taxes. On the estate the average daily income amounted to 2.70—2.80 pengős, which was 33% higher than the average national agricultural wages.² These contractual wages were regularly paid by the estate even if the

² VCA, Zirc Abbey documents, 36. Also: "Conditions of servants and workers" (Extract of the 1938 Annual Report by the manager of the Előszállás estate).

crop year ended with a serious deficit. Only on one occasion was there any modification: in March 1932 there was a sudden rise in the demand for rye; therefore the estate paid the workers in wheat insted of rye.

For the sake of comparison the estate report noted that a small-holder with a landed property of 5—6 ha had an annual gross income of 700—750 pengős and paid 100—150 pengős a year in rates and taxes; thus his actual income was a maximum of 600 pengős a year.

According to the statistical data, the daily wages of agricultural labourers (without provisioning) fluctuated from season to season parallel with changes in the kind of work they did (1930 data):

		Fejér County average	National average
male labour:	spring	2.40 pengős	2.86 pengős
	summer	4.00 „	4.37 „
	autumn	3.00 „	3.20 „
	winter	2.40 „	2.34 „
female labour:	spring	2.00 pengős	2.12 pengős
	summer	3.00 „	3.17 „
	autumn	2.40 „	2.31 „
	winter	2.00 „	1.86 „

(H.S.R. 1930, 262, 268).

The inferior nature of agricultural work in those days is shown by the fact that the daily wages were then 5.80 pengős in the iron and metal industry, 4.19 pengős in the textile industry, 5.38 pengős in the chemical industry, 5.00 pengős in the garment trade, etc.

Among the dwarf-holders, new farmers who were given land during the land reform were undoubtedly in the most serious situation. On the allotted lands an annual 2.5—3.5 q of wheat or 4—6 q of grain maize per hectare could be produced. At the same time, owing to the loss of foreign markets, in April 1930 the purchase price per quintal of wheat fell from 24 to 9 pengős. However, the poor demand made it impossible for the small-holders to sell their grain crops even at these low prices. (In the 1930—1931 crop year 4 million q of unsaleable wheat had to be fed to animals throughout the country.) The price of the allotments, on the other hand, was fixed at 40 q of wheat per hectare, to be paid at a rate of 4 q per year. At the same time a default interest equal to the price of 20 q of wheat was charged. Consequently, the new farmers soon got into debt, particularly after June 1928. (On 9th June the National Chamber of Agriculture officially announced the Hungarian agrarian crisis.) The credit banks wanted to sell up 5000 new farmers in 1929 and 10,000 in 1930 in 28 villages in Fejér County on account of their debts. With a view to "public order", the political leaders of the county did not think this wise. Since they did not consider a postponement in the payment of the instalments desirable either, they suggested a reduction in the price of the allotments (FARKAS 1970b, 125). The rate of interest rose rapidly. While at the beginning of the crisis, on 1st October 1928, the Hungarian National Bank increased the discount rate from 6 to 7%, by December 1930 the credit banks were charging a 10—12% interest in some districts of the Mezőföld (e.g. at Dunapentele). But the credit banks refused to grant credits even on such terms; they were not prepared to enter negotiations with peasants applying for a credit unless they agreed to a three or fourfold mortgage on their property.³

An observer from the Upper Transdanubian Chamber of Agriculture reported from Dunapentele in December 1930: "... As reported from several places, a number of young farmers who have fairly large pig stocks have sold their maize supplies for cash, in the hope that they will be able to buy some later..." According to an observer at Mezőszentgyörgy everybody, large farmers, small-holders and tenant-farmers alike, had run completely into debt; insolvency and compulsory settlement were the order of the day for all classes of farmer. The debts were enormous and the peasants had no income; the potatoes could not be sold, grain prices were extremely low, and lack of money was universal. Distraints and forced sales assumed frightening dimensions. The land slipped away from under an increasing number of small-holders. It was time for the government to interfere in this usurious system of credit

³ Földművelési Minisztérium Levéltára. Általános iratok. (K 184) A Felsődunántúli Mezőgazdasági Kamara mezőgazdasági helyzetjelentése 1930. december hóról. 5—6. [Archives of the Ministry of Agriculture. General documents (K 184). Report by the Upper Transdanubian Chamber of Agriculture on the agricultural situation in December 1930, 5—6. Henceforth abbreviated: AMA-UTCA report.]

policy! The debts snowballed, as not only the loans raised but also the taxes that the small-holders were unable to pay were mortgaged. Only an average of 70% of the 1930 taxes were collected compared to 99% in the previous year. Distraints were effectuated almost everywhere. In many places even the indispensable implements were seized from the farmers and sold at low prices.⁴ Owing to the serious financial conditions neither the large estates nor the small and medium farmers hired any seasonal labour. As a consequence in some places the day-wages fell to 0.30 pengős, which was not even enough for the minimum provisioning of agricultural workers and their families!

According to the December 1930 report of the Upper Transdanubian Chamber of Agriculture the following wages were paid in the Mezőföld:

to seasonal workers (day-wages):

Mezőszentgyörgy (estate): male 1.40, female 1.20, child 0.80 pengős; on small farms: male 1.60, female 1.40, child 1 pengő.

Lovasberény (estate and small farms alike): male 2, female 1.40, child 1.20 pengő.

to contracted labourers on estates (farm servants):

Mezőszentgyörgy: 20 pengős in cash, and 8 q of wheat, 8 q of rye, 2 q of barley, 24 kg of salt and 1 litre/day milk in kind; 0.74 ha of land for maize, 0.08 ha for potatoes, free fuel, 1 sow and its progeny; housing, poultry-yard.⁵

Owing to the rapidly increasing agricultural and financial crisis the agrarian movements revived. A total of eight political parties tried to take the lead in the peasant movements. These parties organized a joint meeting at Székesfehérvár on 7th December 1930, which was attended by 1200 people. The agenda for the meeting included the most serious problems facing the peasantry: marketing difficulties, taxes and the increasing gap between agricultural and industrial prices (FARKAS 1970b, 133).

The situation did not improve, however. The following year, in January 1931, the credit banks charged an interest of 10–13%, but even so they only granted credits to those farmers whose lands were unencumbered. The debts assumed such huge proportions that, according to an observer from the Upper Transdanubian Chamber of Agriculture, in the Mezőszentgyörgy district the low crop prices forced the peasants to take their animals to market, but they could not find buyers for them.⁶ In May 1931 an observer from the Chamber of Agriculture at Mezőszentgyörgy reported a further worsening of the situation: "... All categories of farmers are seriously in debt; they are going bankrupt one after the other... If the grain prices are not readjusted everything will soon collapse and the whole peasantry will be ruined."⁷ According to the report of an observer at Fehérvárcsurgó: "There is a complete lack of money, nobody can pay the rates and taxes!" In July 1931 an observer at Lovasberény reported the following: "... The present state of unemployment will make its effect felt in the winter. The unemployed workers are unable to make provision for the winter now. What will they eat? The government would do well to store the present wheat surplus and distribute it in the winter at a price of 6–8 pengős/q. It is a crime to squander the wheat by feeding it to animals!"

The grain merchants took unfair advantage of the low grain demand. One report gave an account of such a case: "... On one of the grain markets the merchants waited until the last minute, then bought the wheat and rye from the farmers at a price of 3–4 pengős/q. The farmers were driven into a corner and it broke their hearts to hand over the fruits of their hard labour at such prices!"⁸ In September–October 1931 the process of running into debt came to a halt because the banks stopped granting credits. Credit was only granted with a mortgage, and even then at a rate of 12–18%!⁹

According to the report of an observer at Csákberény in October 1931: "... Owing to the unsaleableness of grain and animals there is a general lack of money... People are indifferent, resigned and hopeless... The farmers and agricultural labourers only have sufficient grain for 3–4 months. They cannot obtain any money since they are unable to sell their grain crops, animals and wine even at half price. Many sober, economical families have become completely down-and-out." Dunapentele: "... The taxes are to be collected through distraints and forced sales. However, since there are no buyers, this cannot be put into practice either!"

⁴ AMA-UTCA report, December 1930. 6. General reflections, 8–9.

⁵ AMA-UTCA report, id.

⁶ AMA-UTCA report, February 1931.

⁷ AMA-UTCA report, May 1931.

⁸ AMA-UTCA report, September 1931.

⁹ AMA-UTCA report, September–October 1931.

According to the statistical data, up to 31st December 1931 the following loans had been given to estates in Fejér County:

- number of debtors: 8763 (70 of whom owned 55—1100 ha);
- encumbered area: 166,890 ha;
- total sum of loans: 50,171,870 pengős (H.S.R. 1932, 960).

The increasing difficulties caused a government crisis. On 1st June 1932 the agrarian representatives of the government party handed in a four-point demand: 1. immediate reduction in the interest rate; 2. urgent redistribution of land; 3. facilitation of the situation of those given land; 4. rise in the purchase price of wheat. The crisis forced the Károlyi government to resign on 21st September 1932. The Gömbös government formed on 1st October published its 95-point "National Work Plan" on 25th October; this promised to meet the demands by carrying out land and tax reforms, by settling the agricultural debts, by granting cheap credits, by opening up agricultural markets and by creating job possibilities. The consequences of the Hungarian—Italian commercial contract drawn up on 10—13th November could already be felt in December: exports to Italy increased, and everybody looked forward to prospective trade agreements with Austria and Czechoslovakia.¹⁰ In December 1932 the grain prices continued to fall, in spite of the agreements. The reason for this was the merciless collection of government taxes, since the government continued to ignore the actual crop prices (4 pengős/q for rye and 5 pengős/q for maize) when fixing the taxes. By January 1933 the credit and money situation touched bottom: the farmers were no longer given credit even in the form of a mortgage. According to reports even the large estates did not hire seasonal labour (day-workers) any longer. The sale of agricultural produce was hampered by the government decree that raised the tariff for lorry transport, which was previously some 50% cheaper than rail transport.¹¹

As a result of the general agricultural crisis the price of land was also reduced to a minimum. One hectare of arable land fetched less than 200 pengős. The land was bought up not by farmers but by speculators. An observer of the Upper Transdanubian Chamber of Agriculture reported from Csákberény in February 1933: "... Owing to the present agricultural recession small and medium landowners cannot buy land. They are thankful if they can keep what they have now!"

The transport situation also took a turn for the worse. In order to aid the railways the government confined lorry transport to a distance of 30 km — even with the raised tariff! The farmers therefore covered distances of 70—80 km in their own horse-drawn vehicles. "... Village transport will slowly return to conveying everything by cart!" — wrote observers from many districts of the Mezőföld.¹² Of the loudly publicized "National Work Plan" all that was ultimately executed was a 2.5% reduction in the interest rates for indebted farmers in August 1933. The conservative leadership of the Upper Transdanubian Chamber of Agriculture submitted a proposal to the Ministry of Agriculture and the government in October 1933, demanding a radical settlement of land problems, whereby the government should protect and industrialize the large estates instead of propagating the distribution of land, as only the modern industrialized large-scale farms were able to give employment to the great number of jobless village people. They also demanded that dwarf-holders and landless peasants should only receive land suitable for intensive management (vegetable gardens, vineyards, hop cultivation, production of raw materials for handicrafts).¹³

The economic agreements concluded with Austria and Italy on 16th May 1934 did not bring about any kind of improvement in the economic life of the Mezőföld. Owing to the continuing low grain and animal prices the farmers were unable to make any money. According to a report in May 1934: "... Agricultural labourers who were given land in the course of the land reform, and those small-holders whose landed properties have reached a size of 5—6 ha together with the allotted land are in a particularly adverse situation ... On the one hand they have become seriously indebted, on the other hand, they are forced to live off their produce, so they cannot take anything to market and are thus unable to pay off their debts. At the same time, the land absorbs the family's whole time and energy, so they cannot even undertake to do wage-work." In March 1935 the government again made an agrarian statistical survey to see whether or not a land reform was necessary. The Upper Transdanubian Chamber of Agriculture was still against the land reform. In their opinion a large estate can provide for more people; machines, expertise and marketing possibilities can be better exploited

¹⁰ AMA-UTCA report, December 1932.

¹¹ AMA-UTCA report, February 1933.

¹² AMA-UTCA report, April—May 1933.

¹³ AMA-UTCA report, October 1933.

than when the land is broken up into small plots.¹⁴ They continued to consider "autocratic financial management" to be the cause of all the trouble: "... Very little of this money, which is not worth the paper it is printed on abroad, reaches those who do productive work, and least of all those who dig the soil! Unless the nation is liberated from the tyranny of capitalist finance... everything will be irretrievably lost: first the large estates and then the small-holdings too!"

In spite of the promise made by the National Union Party under the leadership of Gyula Gömbös that a series of radical economic reforms would be introduced — nothing happened. According to the report of an observer at Rácalmás, 75% of the farmers remained indebted, and the peasants did not have enough money to buy even the most necessary goods.¹⁵ It was only on the credit scene that some improvement appeared from February 1936. The banks began to grant small credits to farmers; the rate of interest was 5% on farmers' loans and 7.5% on other loans. By October unrestricted credits were given in exchange for threefold security and a 7—8% rate of interest. The improvement made its effect felt by February 1937: the grain and animal prices slowly began to rise. But then the negotiations begun at government level between Hungary and Germany in July 1937 foreboded the programme of rearmament announced in March 1938. Early in summer 1937 large-scale construction work, indirectly or directly of a military character, was started in many places in the region. The construction of the strategically important main road (No. 8) from Székesfehérvár via Veszprém to Graz began. In the districts of Veszprém and Székesfehérvár airfields were established and in Székesfehérvár war factories were built. The increased labour demand raised the wages. In July 1937 the large estates paid day-wages of 2.00—2.50 pengős to men, 1.30—2.00 pengős to women and 0.90—1.70 pengős to children; men doing work for small-holders received 1.80—3.00 pengős as day-wages.¹⁶ One of the reasons for the slow improvement was undoubtedly the fact that the permanent misery of the people was a breeding ground not only for the leftist revolutionary forces; with the evolution of the German Third Empire the agrarian proletariat of the Mezőföld proved susceptible to the doctrines of national socialism as well! Attention was called to this situation, which endangered the capitalist social order, by the Upper Transdanubian Chamber of Agriculture in April 1936: "... The underground revolutionary organizations of students and workers come to light here and there in the towns, but never in the villages, because the police and the press do not look there... Misery has driven the people wild and filled with hatred for the upper classes and with social nihilism... Economic and moral slavery, with its inevitable revolutionary backlash, is frighteningly near!"¹⁷

3. Situation of agriculture in the Mezőföld between 1928 and 1937

A) Field crop production between 1928 and 1937

Because of the excellent soil conditions the production of major crops (wheat, rye, barley, oats, maize, potatoes) in the Mezőföld exceeded the national average. In Fejér County, which occupied most of the area of the regional unit, the yields of major crops exceeded the national average by 135—140% in the Vâl and Sârbogárd districts and the town of Székesfehérvár, by 130—135% in the Adony district, by 115—120% in the Székesfehérvár district and 100—105% in the Enying district (H.S.R. 1928, map II/2). Owing to the excellent conditions for field crop production, and the vicinity of Budapest as a big outlet, 67.1% of the 412,216 ha cultivated area in the county consisted of arable land. These figures were far higher than the average for Transdanubia (1928: 37.2%, 1937: 37.4%) and even than the national average (1928: 60.1%, 1937: 60.4%) (GUNT 1970, 106, 116).

Since earlier data are not available, the types of estate and the arable areas are compared on the basis of the 1935 survey:

dwarf-holdings:	30,518 ha	arable land,	63.7% of the total area;
small-holdings:	99,329 ha	" "	80.5% of the total area;
medium estates:	42,126 ha	" "	54.0% of the total area;
large estates:	105,670 ha	" "	58.1% of the total area;

¹⁴ AMA-UTCA report, March 1935.

¹⁵ AMA-UTCA report, November 1935.

¹⁶ AMA-UTCA report, July 1937.

¹⁷ AMA-UTCA report, April 1936. "Appendix."

The total area of arable land in Fejér County and Székesfehérvár was 277,643 ha. In Fejér County this made up 67% of the total cultivated area, while in Székesfehérvár it represented only 3.3% (H.S.R. 1938, I, 267).

From the above data it can be seen that the small-holdings had larger than average arable areas. The dwarf-holdings were next in order. This was not a good solution, as intensive management (vegetable gardens or vineyards, etc.) would have ensured a higher income for the dwarf- and small-holders.

In Fejér County and Székesfehérvár various crops were produced on the following percentages of the 277,643 ha total arable area (in 1934):

grain crops	46.1%
maize, potatoes, beets	31.7%
roughage	17.1%
other crops	4.0%
fallow	1.0%
(H.S.R. 1935, 283).	

With regard to row crops (maize, potatoes, beets) Fejér County was above the national level (30.25%), and the situation was similar for rough fodders, the national average for which was 12.43% in 1934. It was only for grain crops that the county was below the national average (53.88%) (GUNT 1970, 120).

A/1. Grain crop production between 1928 and 1937

With respect to the area sown with grain crops (46.1%) the Mezőföld was below the national average (53.88%) in 1934. In the period concerned the area sown with grain crops showed a decreasing tendency both nationally and on a county scale. By 1937 the national average fell to 50.8% and the county average to 43.8%.

There are no data available on the percentage sowing area of grain crops (wheat, barley, rye, oats) in the first years of the period discussed. From the end of the Great War up to 1928, the most important field crop was wheat, followed by rye, barley and oats. The 1937 data are more or less characteristic of the whole period. In that year 43.8% of the 274,872 ha arable area of Fejér County was sown with grain crops, 59,089 ha with wheat, 22,950 ha with rye, 22,491 ha with barley and 11,666 ha with oats (H.S.R. 1938, I, 268). Similar proportions were found on the 17,240 ha Előszállás estate of the Cistercian Abbey at Zirc, the largest landed property in the Mezőföld. Of the 11,495 ha of arable land 4904 ha was sown with grain crops in 1931, in the following distribution: 2168 ha of wheat, 828 ha of rye, 893 ha of winter and summer barley, and 1037 ha of oats. In the following year, 1932, 4781 ha was sown with grain crops: 2127 ha of wheat, 878 ha of rye, 913 ha of winter and summer barley, and 873 ha of oats.¹⁸

The record grain yield (particularly of wheat) in 1928 strengthened the drop in prices caused by the world overproduction of wheat. The price of wheat, which was 30 pengős/q before 1928, fell to 9 pengős/q by 1933, while the price of rye fell from 24 pengős/q to 5 pengős/q during the same period.¹⁹

In the years between 1930 and 1934 grain production showed a general decline, due primarily to the ever decreasing purchase prices, and in some part to the unfavourable weather conditions. The 1930—1931 crop year started well from the point of view of grain production. The crops came up well in the mild autumn weather and were covered with snow after 20th December 1930. In the mild weather of January 1931 the snow cover disappeared, then between 12th and 18th February a mass of snow came down on the soaked, wet fields, covering them to a depth of 1—1.5 m. What was left of the crops after the unexpected frost and snow storms suffocated under the snow. From March onwards the weather constantly changed: warmer periods during the day were followed by night frosts. In the spring months weeds, insects and mice caused damage: in the Kápolnásnyék district the whole of the autumn crops, and in the neighbourhood of Dunapentele the barley and rye stands had to be ploughed out because of damage caused by ground-beetles. Immediately before harvesting began, on 25th June, devastating hail-storms damaged the grain crops, causing a 50% loss in the Dunapentele district. The 1931 summer grain yield was 2.5—3.5 q/ha less than in the previous years.²⁰ On the Előszállás estate of the Cistercian Abbey at Zirc the 1931 crop year was cata-

¹⁸ VCA, Zirc Abbey documents, 28.

¹⁹ AMA-UTCA report, December 1930, August 1933.

²⁰ AMA-UTCA report, December 1930, January—June 1931.

strophic, "... there has not been such a bad crop yield in living memory".²¹ Wheat, which was sown on 2168 ha, gave a yield of 311 wagons (with a net average of 14.5 q/ha). The 828 ha sowing area of rye produced a yield of 117 wagons, with a net average of 14.18 q/ha. Winter and summer barley gave a 60 wagon yield on 893 ha, with a net average of 11.2 q/ha. The yield of oats, which was sown on 1037 ha, was 59 wagons, with a net average of 5.7 q/ha.²²

June again started with a severe drought which lasted for eight weeks. (The average precipitation in June and July was 29 mm.) There were hail-storms instead of rainfall, which caused particularly severe damage in the second half of July. In the Ercsi district the hail-stones were sometimes the size of a hen's egg, and the loss was, in general, 100%. The damage was increased by strong wind-storms, which caused 10—20% losses in oats. A hail-storm which swept over the Lovasberény—Fehérvárcsurgó district resulted in 30% losses on an area of about 300 ha at Lovasberény; at Fehérvárcsurgó the damage done by hail reached 60%. On 2nd August, after eight weeks of drought, the rain began to fall. However, the negligible amount of precipitation did not help much; on the dry soil the August ploughing only progressed with great difficulty. Not only ploughing, but also fertilization was difficult to carry out, and came to a halt almost everywhere, on large estates and small-holdings alike. With a wheat price of 8 pengős/q the farmers, particularly the small-holders, could not afford to buy fertilizer at a price of 12 pengős/q. In several villages the small landowners declared that they would not buy fertilizer until the price of wheat was adjusted to that of fertilizer. Instead they returned to the traditional practice of manuring. However, owing to the poor grain yield in the summer of 1931, manuring was also uncertain. By the autumn and winter months the price of straw for litter rose to 6 pengős/q!

The summer drought was followed by overabundant rain and cold weather in the second half of September. Though the oats were generally sown, the unfavourable weather prevented the sowing of wheat. In the first half of October the weather improved, then after 15th October the cold set in again, accompanied by strong winds and rain. November brought good weather; the winter crops, wheat, rye and barley, generally developed well. December, on the other hand, began with dry, cold weather, without any snow, and this was characteristic of January and February 1932 too. By that time, however, the spring crops were fairly strong, but the autumn crops were seriously damaged by the frost due to the lack of snow cover: in the Lovasberény district 40% of the winter barley had to be ploughed out. May began with dry, warm weather, but on 18—20th May a huge storm swept over the greater part of the Mezőföld, bringing 30 mm of rain and hail. Along a line stretching from Alcsút to Alap 100% of the rye was damaged. Then the drought in May and June finally set the grain stands back: the wheat was low and thin in most districts, and the rye was similarly poor.²³ In June 1932 the grain yield was somewhat better than in the previous year, but the straw yield was low. On the estates of the Zirc Abbey 837 wagons of grain were produced on 4781 ha: 353 wagons of wheat on 2127 ha (an average of 16.56 q/ha), 146 wagons of rye on 878 ha (a net average of 16.61 q/ha), 12 wagons of winter barley on 66 ha (net average: 17.12 q/ha), 173 wagons of spring barley on 816 ha (net average: 21.12 q/ha), and 153 wagons of oats on 873 ha (net average: 17.20 q/ha).²⁴

During the warm, dry weather in June—August 1932 the grain sown in spring developed excellently, but the prolonged dry period threatened disaster again. The dry weather caused difficulty in soil preparation. Besides the meteorological problems people were worried by the high fuel prices too. Owing to the lack of money the tractors were not used; on the small and large estates they returned to horse-drawn ploughing. Even on the Előszállás estate of the Zirc Abbey the 11 tractors were withdrawn from ploughing, and 884 draught-oxen were put to work instead. Owing to the lack of straw in the previous year there was very little farmyard manure. Fertilization was hardly carried out anywhere; with the price of wheat at 8 pengős/q the farmers could not afford to buy fertilizer at a price of 12 pengős/q. The difficulties were increased by the lack of rain from 5th August till the end of September. Owing to the drought, masses of wireworms and agrotis larvae appeared in the Kápolnásnyék district. After the rainy period beginning at the end of October only the large estates could carry out the autumn ploughing. The small-holders' lands remained unploughed in many places. The favourable weather in October—November did the grain crops good, but the dry, cold December brought new dangers. There was no snow until 19—25th January. The rapid thaw at the end of Feb-

²¹ VCA, Zirc Abbey documents, 28.

²² VCA, Zirc Abbey documents, 28.

²³ AMA-UTCA reports, July, August, September 1931; January, February, March, April 1932.

²⁴ VCA, Zirc Abbey documents, 28.

ruary endangered the crops yet again. The autumn sowing generally overwintered well, but those sown in spring were slow to emerge. The dry, cold, windy weather in April was also unfavourable: the wheat and rye stands were thin and underdeveloped.²⁵ In spite of the difficulties the wheat was generally satisfactory according to the June 1933 reports; the spikes were medium long and the grain formation was sufficient. The rye and autumn barley developed well; the oats were low but produced very good ears. The July and August drought again made soil preparation difficult, and great problems arose with the unusually large number of mice and gophers. Grain crops which were sown in dry soil in autumn emerged poorly in October. (The soil was so dry that at Sárkeresztúr the labourers had to smash the big lumps of earth with axes.) On 15th October a rainy period began; it poured torrentially for over a month (156 mm). The growth of the autumn crops was checked. Owing to the heavy rainfall fertilization and ploughing in preparation for the spring crops met with difficulties, too. Since 50–70 cm snow fell in the middle of December and the frost improved the roads, fertilization was resumed. In the Rácalmás district the manure was spread over the snow, which was a waste of the expensive farmyard manure.²⁶ The long-drawn-out frosts in January and February 1934 caused great damage to the grain crops. In spite of the dry windy weather in March, the ploughing which had proved impossible in autumn was completed in many places, and the barley and oats were sown. Eleven days of dry weather in April checked the development of the autumn barley and rye in many districts. The drought continued in May and caused unimaginable losses; in the districts of Nagylók and Sáregres the destruction it caused in the grain stands was qualified as a disaster.²⁷ In the unfortunate year of 1934 drought destroyed 880 ha, frost 972 ha and hail 982 ha in Fejér County. Due to the elemental calamity 796 ha of wheat, 682 ha of rye, 320 ha of barley and 116 ha of oats went to waste (H.S.R. 1935, 988–989). During the favourably rainy weather from July to September soil preparation was carried out according to schedule. The favourable soil conditions made it possible to complete the various ploughing operations (ploughing under of stubble, preparation for spring crops, etc.). It was only in the Kápolnásnyék district that fertilization represented a problem owing to the lack of farmyard manure. In the pleasant, warm weather in October and November autumn-sown grain crops developed strongly, and only the mild, rainy December threatened them with any danger. Low-lying lands became waterlogged, and in any places there was intensive weed growth.²⁸ On 18th January 1935 the snow began to fall, and in spite of the severe cold (10–15°C below zero) the crops overwintered well under the snow. In addition to the favourable weather, after so many years the grain prices not only stopped falling but even began to rise. However, because of the poor grain yield in the previous year, the supply of grain on the market was low. A sudden thaw at the end of February, followed by snowfall early in March did not cause any significant damage to the crops. Later, however, the growing stands were severely injured by frost on 3rd May. In the Nagylók district 50–100% losses occurred in the rye; in many places the grain stands had to be ploughed out. June started with dry weather. The drought was worsened by great wind-storms between 6th and 16th June. In the June–July drought the ripening grains (particularly the wheat) shrivelled and consequently yielded poorly. In the neighbourhood of Magyaralmás a shock of barley produced 35 kg grain and a shock of wheat 50–58 kg. The badly needed rainfall arrived on 14th August, but a tornado-like storm caused great damage. The grain yield was so poor that a nation-wide famine was feared. The autumn did not begin well either; from 10th September to 24th October the weather was so dry that hardly any of the autumn soil preparations could be accomplished. Rain began to fall on 24th October; from then to 22nd November the amount of precipitation was 50 mm. Soil preparation was duly started, and the grain crops sown in September began to emerge, though very poorly. From the end of November a mixture of rain and snow fell, and when a snow-cover finally formed, the crops below it were sodden. In addition, by Christmas the snow-cover had thawed. It was only after the end of December that a uniform snow cover finally protected the crops.²⁹ In February 1936 the snow disappeared, and the fields were soaked by rain. (By 27th February the amount of precipitation was 144 mm.) In spite of the fact that the snow disappeared the winter crops developed well. In the favourable weather sowing started on 12th March. The grain crops,

²⁵ AMA-UTCA reports, July, August, September, October, November, December 1932; January, February, April 1933.

²⁶ AMA-UTCA reports, June, July, August, September, October, November 1933.

²⁷ AMA-UTCA reports, January, February, March, April, May 1934.

²⁸ AMA-UTCA reports, June, July, August, September, October, November, December 1934.

²⁹ AMA-UTCA reports, January to December 1935.

that grew vigorously in April, were laid low by heavy rainfall in May. Then rainstorms on 12th June again severely damaged the grain stands that had revived by then. In the vicinity of Nagylók 50—100% losses occurred on about 920 ha.

In the summer of 1936 the grain yields were very poor again. Wheat yields were particularly low. In the Magyaralmás district the following crop yields were obtained: 8—9 q/ha of wheat, 12 q/ha of rye and 13—14 q/ha of barley. The long period of drought in July, August and September again caused great difficulties in the autumn soil preparation. The heavy rains in October following the drought delayed the emergence of winter rye and barley. The rainy, cold weather was protracted until December and assumed such proportions that soil preparation and sowing could not be completed in many districts. The snowfall, that started on 2nd December, did not last long, and the grain crops were left without a snow cover.³⁰ By the time the snow arrived in the middle of January 1937, the frost had done great damage, particularly in the winter crops. Owing to the changeable weather conditions in February, with thaws in the day-time and frost at night, and the subsequent heavy rainfalls in March, the grain stands were of inferior quality. Due to the large amount of precipitation weeds, mice, field-mice and insects caused considerable damage everywhere; in the Nagylók district 40% of the winter barley and rye had to be ploughed out. Since the amount of precipitation was 194 mm in March and 64 mm in April, low-lying lands were left uncultivated in many places, and large areas were covered by water. The poorly developed stands of winter wheat, rye and barley were seriously affected by the torrential rain and hail-storm on 22nd May. Particularly great damage occurred in the neighbourhood of Rácalmás and Seregélyes.³¹

The grain yield in the summer of 1937 was again poor to medium. In Fejér County (excluding Székesfehérvár) the following yields and yield averages were obtained in 1937: wheat: 797,571 q from 59,089 ha; average yield: 13.57 q/ha; rye: 269,270 q from 22,950 ha; average yield: 11.83 q/ha; barley: 259,086 q from 22,491 ha; average yield: 11.48 q/ha; oats: 156,093 q from 11,666 ha; average yield: 13.40 q/ha. (H.S.R. 1938. I, 268—269.)

A/2. Row crop production between 1928 and 1937

Data on the percentage proportions of row crops during the first years of the period concerned are not available. Since the number of livestock in the Mezőföld was always large (while the natural grass-land area was small), the area sown with row crops was always larger than the national average. In 1934 it was 31.7% of the total arable area, compared to the 30.25% national average. By 1937 this proportion rose to 33.2%, while the national average was 30.6%. The large estates were the main producers of row crops. Of the 11,495 ha arable area of the Előszállás estate (total area 17,240 ha) belonging to the Cistercian Abbey at Zirc, maize was grown on 1460 ha in 1931 and on 1473 ha in 1932. Fodder beet was produced on a much smaller area: on 64 ha in 1931 and 133 ha in 1932; the production area of potato was still less: 22 ha in 1931 and 30.5 ha in 1932. The sugar-beet production was also considerable, occupying 242 ha in 1931 and 337 ha in 1932.³²

After 1928 the world crisis caused by agricultural overproduction created a grave situation in maize production as well. While before 1928 1 q of maize cost 28 pengős, by 1934 the price fell to 4—5 pengős. The situation was similar for potatoes: the December 1930 reports of the Upper Transdanubian Chamber of Agriculture remarked that the demand had totally ceased to exist: the potatoes were unsaleable.

The catastrophic yield in 1931 applied to the row crops too. In May 1931 50% of the beets in the Dunapentele district had to be ploughed out because of cabbageworms and fleas, while in the neighbourhood of Lovasberény the gophers, that appeared in unusually large numbers, caused 10% losses.³³ The severe drought in July arrested the development of beet and maize. The rain which arrived on 2nd August, after the eight-week drought, only resulted in a growth in the existing ears of maize. Then the large amount of precipitation in September destroyed what was left of the maize, potatoes and beets. When the maize harvest began at the end of September only the early maize could be harvested; the late-maturing maize was still completely green. In spite of all this the 1931 autumn harvest still gave a relatively good yield of row crops. On the Előszállás estate of the Zirc Abbey 380 wagons of maize were pro-

³⁰ AMA-UTCA reports, January to December 1936.

³¹ AMA-UTCA reports, January to December 1937.

³² VCA, Zirc Abbey documents, 28.

³³ AMA-UTCA reports, May, June 1931.

duced on 1460 ha, which meant a yield average of 26 q/ha. This corresponded to the conditions found in the Mezőföld and by far exceeded the 13.6 q/ha national average and the 15.3 q/ha average for Transdanubia. The 64 ha production area of fodder beet yielded 114 wagons; this 210.5 q/ha yield average was also much higher than the national average (167 q/ha). Potatoes, which were grown on 22 ha, gave a yield of 11 wagons, which was equivalent to a yield average of 52.2 q/ha, i.e. less than the 64.5 q/ha yield average characteristic of estates larger than 580 ha. Sugar-beet was sown on 242 ha and produced a total yield of 437 wagons, with a yield average of 179 q/ha. This was again less than the yield average (190 q/ha) characteristic of estates larger than 580 ha.³⁴ The summer of 1932 was also too dry for the row crops; as a consequence wireworm and apion attacked the fields in several districts in June. The July rains helped the row crops considerably; the potatoes looked particularly promising. The Fehérvársurgó district was the only place where things were going badly: insect pests overran and destroyed whole potato fields. In other districts potato-rot appeared, sometimes causing 60–80% losses. In the neighbourhood of Mór phytophthora and stem rot attacked the potatoes and led to the destruction of the whole crop, as a consequence of the drought. In the vicinity of Sározd the potato tubers remained small for the same reason, and many of them were shrunk. The maize, on the other hand, generally yielded well, and the yields of fodder beet and sugar-beet were also good.³⁵ Yields increased on the Előszállás estate of Zirc Abbey as well. The 1473 ha maize area yielded 700 wagons; potatoes were grown on 30.5 ha and produced 25 wagons; fodder beet yielded 400 wagons from an area of 133 ha, while the yield of sugar-beet obtained from 337 ha was 750 wagons.³⁶ (Data on average yields/ha are not available.)

The dry, cold, windy weather characteristic of March and April 1933 set the row crops back to a great extent: the potatoes did not come up, the beets emerged slowly and unevenly, and the maize stopped growing. In June insects caused considerable damage to fodder beets everywhere. The difficult situation was not changed until warm rain arrived in July, though the two months of drought resulted in irreparable damage in many places. The potatoes showed signs of forced maturation almost everywhere: there were very few tubers and even those were small and mostly diseased. Fodder beet was parched by the sun in most places, and so was the maize in many districts. When the maize was harvested in October the ears turned out to be underdeveloped. And the harvested maize went rapidly bad and mouldy. In the small-holdings harvesting advanced very slowly: the maize harvest, which was pilfered by game and crows, was not completed until the middle of January 1934.³⁷ The spring of 1934 also began unfavourably; in April insects and fleas did considerable damage to beets in the districts of Szilfámajor and Rácalmás. Then, owing to the dry weather from 7th April till 18th May, the maize could not be sown. Rainfall in June brought about some improvement: in July and August the row crops developed well. By the time of the autumn harvest maize and potatoes generally yielded satisfactorily.³⁸ In some places (Nagylók, Sáregres), however, the early summer drought was disastrous: 174 ha of maize and 137 ha of potatoes were destroyed (H.S.R. 1935, 989).

The year 1935 started well: in the warm June weather the row crops began to develop vigorously. However, in July and August the warm weather turned into a devastating drought. The rainfall which began on 14th August was too late to save the row crops in most places. As regards the maize, the late dent corn variety Fleischmann was still able to make use of the rain (though the expected yield was only 19 q/ha), but the white maize and other maize varieties were destroyed. The rain came too late to help the potatoes too; not even enough tubers were produced to replace the seed tubers. In most places the yield was not larger than 26 q/ha. The rainfall was of most assistance to the fodder and sugar-beets, but even so the yield was 30–35% lower (174–180 q/ha) than in normal years.³⁹ In 1936, due to the favourable warm, rainy weather, the row crops developed well. However, when the crops were harvested in October the maize and potato yielded moderately and the beets poorly. In spite of the low crop yields the price of maize declined further in September and October; 1 q cost 4.50 pengős. Harvesting was greatly hindered by the heavy rainfall which began in November.⁴⁰

In the spring of 1937 the row crops were sown late because of the rainy weather in April. Although the rain, which continued to fall in May, made the fertilization of the row

³⁴ VCA, Zirc Abbey documents, 28. Also: GUNST 1970, 171, 173.

³⁵ AMA-UTCA reports, January to December 1932.

³⁶ VCA, Zirc Abbey documents, 28.

³⁷ AMA-UTCA reports, January to December 1933.

³⁸ AMA-UTCA reports, January to December 1934.

³⁹ AMA-UTCA reports, January to December 1935.

⁴⁰ AMA-UTCA reports, January to December 1936.

crops difficult, the plants developed satisfactorily. According to the July reports the good condition of the row crops was the only thing that promised some compensation for the poor grain yield. In spite of the rainy weather at harvest time in October the row crops yielded well. In the autumn of 1937 the following yields were obtained in Fejér County:

maize: a total of 1,645,893 q of grain maize from 70,903 ha; an average yield of 23 q/ha (national average: 23 q/ha);
 potatoes: a total of 813,204 q from 8735 ha; an average yield of 90.6 q/ha (national average: 86.8 q/ha);
 fodder beet: a total of 1,114,244 q from 4867 ha; an average yield of 228.8 q/ha (national average: 231 q/ha);
 sugar-beet: a total of 646,708 q from 3055 ha; an average yield of 212 q/ha (national average: 215 q/ha).
 (H.S.R. 1938, I, 268—269.)

A/3. Production of roughage crops between 1928 and 1937

Owing to the fact that livestock keeping was a dominant branch of agriculture in the regional unit, the production area of roughage crops (17.1% of the arable area) also exceeded the national average (in 1934). From 1931 it increased steadily (this was, in fact, a nationwide phenomenon), until in 1937 17.5% of the arable area in Fejér County was sown to roughage crops, compared to the 12.3% national average. The roughage crops showed the following order (in 1932) on the basis of the sowing area:

saintfoin: 1074 ha yielded 5233 q; average yield:
 4.87 q/ha; national average: 4.87 q/ha;
 alfalfa: 970.68 ha yielded 4090 q; average yield:
 4.17 q/ha; national average: 3.48 q/ha;
 Hungarian grass: 526 ha yielded 4079 q; average yield:
 7.83 q/ha; national average: 8 q/ha;
 clover: 514 ha yielded 1765 q; average yield:
 3.3 q/ha; national average: 2.26 q/ha;
 crimson clover: 127.5 ha yielded 555 q; average yield:
 4.35 q/ha; national average: 5.22 q/ha.
 (H.S.R. 1933, 159.)

Although the percentage proportion of the roughage area was generally higher than the national average, there was a great shortage of rough fodders every year. And this had an adverse effect on livestock keeping in general, and on cattle farming in particular. Since the roughage crops listed above played a particularly important role in the small and medium-size peasant farms (70% of these crops were produced on farms of less than 55 ha), their yields fundamentally influenced the success of livestock farming (above all: cattle farming) on these farms. From 1922 to 1930 the production area of roughage crops generally decreased, then from 1930 it slowly began to grow. After a chronic shortage of rough fodder in 1928—1929 the yield in 1930 was so good that in January 1931 the farmers no longer complained of fodder deficiency. It was only from the Mezőszentgyörgy district that a shortage of rough fodder was reported in February—April 1931. The roughage had to be supplemented with increased grain fodder rations. The year 1931 started badly: as a consequence of dry cold weather in April large areas of clover and saintfoin were damaged by frost in some districts (Dunapentele, Ercsi). Because spring was late in coming, the fodder supplies were depleted by May in some places. In the dry summer the grasslands were parched by the sun by July, and in many districts (Nagylók, Dunapentele) the farmers were compelled to keep the animals on feed reserved for the winter. After the drought the weather turned cold in September, and the abundant rain completely destroyed the roughage stands. By December 1931 and January 1932 the rough fodder deficiency assumed catastrophic proportions. In several districts (Csákerény, Alap, Dunapentele) the farmers fed the animals with chaff, maize stalks and straw intended for litter. Straw for litter became so much sought after that it cost 6 pengős/q. Using the litter as feed, on the other hand, involved the danger that farmyard manure would be in short supply the following year, and this, in turn, caused problems in crop production.⁴¹ The Előszállás estate of the Cistercian Abbey at Zirc was also in great need of roughage crops, and had to feed maize stalks and litter straw to the animals. The management of the estate had to choose between two possibilities: either to reduce the livestock, or to spend the working

⁴¹ AMA-UTCA reports, January to December 1931.

capital of the estate on buying feed concentrates. The latter was chosen: the estate purchased 269 wagons of grain fodder and 24 wagons of dried beet-slices for a total sum of 307,000 pengős.⁴² By April 1932 the shortage of fodder and litter straw culminated. In the Csákberény district there was often no litter for the animals in the stables and cow-sheds. In other places the animals were turned out to grass from the middle of April, although the pastures were still bare. By May the weather became so dry and hot that the Pannonian vetch mixture did not even refund the cost of the seed. The saintfoin was unable to blossom and dried out. The yield of alfalfa only reached the quality and quantity usual for the second and third after-crops. In June 1932 the serious shortage of fodder forced the farmers to sow larger areas with roughage and other fodders (millet, Hungarian grass). Rainfall in July somewhat improved the situation, but the drought in August set everything back again, and the fear of a winter fodder shortage reappeared.⁴³ However, by supplementing the rough fodders with cob-meal and bran both the small and large estates pulled through the winter.

In May 1933 the fodder situation was varied. In the Nagylók district there was a shortage of fodder, in the neighbourhood of Csákberény the situation was satisfactory, while at Lovasberény there was a surplus 100 wagons of fodder. The cold, rainy weather in June 1933 set the roughage crops back again: the alfalfa decayed in most places, the clovers were very poor and the mixed stands of oats and vetch hardly developed. Then the drought from August to October destroyed all that was left. The pastures were parched by the sun, and the farmers faced a hard winter again.⁴⁴ The feeding problems were solved by the low grain prices, because of which the farmers fed the unsaleable grain to the animals. The year 1934 did not begin well either. Owing to the dry weather in April, and because of the damage done by mice, the roughage crops developed very poorly. Due to the drought the grasslands were slow in turning green. The rye and barley crops destroyed by the long drawn-out dry weather (from 7th April to 18th May) had to be cut for feeding purposes. The fields were then ploughed up again and, to prevent a new fodder shortage in winter, sown with green maize, Hungarian grass and millet. However, the newly sown roughage crops yielded very poorly. According to surveys made in August their yields were 40% less than was necessary. Because of the serious deficiencies a number of farmers tried to sow saintfoin in the autumn — with varying results. The problems were lessened by the fact that the animals could be left out to graze until late in the autumn of 1934.⁴⁵ Early in the spring of 1935 the fodder shortage again assumed catastrophic proportions. The situation was made even worse in March 1935, when many farmers took their limited fodder reserves to Budapest where the dairy farms paid as much as 10–12 pengős for 1 q of fodder. In May the animals were put out to the thin grazing lands almost everywhere. The June–August drought destroyed everything again. The grasslands were scorched and the fodder plants gave hardly any yield; 95% of the supplementary fodder crops (Hungarian grass, millet, Sudan grass) were also completely scorched. Only the perennial fodder plants produced a small amount of yield. The prices of feed concentrates rose: bran and darnel-meal cost 0.12 pengős/kg. Since the farmers were pinched for money, they were forced to begin feeding the winter fodder by July. According to reports, there was only enough feed to supply the livestock until the end of December at the most. In August the Upper Transdanubian Chamber of Agriculture suggested stopping the use of straw and maize stalks as fuel in the villages and estates, since this would cover 60–70% of the fodder deficiency. Owing to the catastrophic situation many farmers wanted to get rid of their animals, but the prices were so low that they could only sell them at a loss. Many of those who were better off tried to buy molasses from the sugar factories. This was hampered by the lack of iron barrels.⁴⁶ The disastrous winter was followed by favourable early spring weather in 1936. By May the meadows and pastures became green, and the alfalfa and saintfoin fields developed well. Grazing, green-feeding and rye feeding began. The summer passed without any problems. In July the farmers showed interest in growing papilionaceous plants suitable for improving the fertility of the soil. July 1936 brought an abundant fodder yield, and the fodder crops sown after the harvest (millet, Hungarian grass, green maize sown thickly for use as fodder) paid well in August. After so many years there was no threat of fodder deficiency in the winter of 1936–1937.⁴⁷ The only shortage was of straw for litter; this was substituted by chopped maize stalks on large estates and small-holdings alike. The winter passed without any dif-

⁴² VCA, Zirc Abbey documents, 28.

⁴³ AMA-UTCA reports, January to December 1932.

⁴⁴ AMA-UTCA reports, January to December 1933.

⁴⁵ AMA-UTCA reports, January to December 1934.

⁴⁶ AMA-UTCA reports, January to December 1935.

⁴⁷ AMA-UTCA reports, January to December 1936.

ficulties, and by April 1937 the fodder crops emerged and grew vigorously. The hot June weather set the fodder crops back here and there; the saintfoin gave a very poor yield (3.4—6.9 q/ha). The alfalfa and Hungarian grass, on the other hand, yielded well in all districts. The good weather was also favourable for the mice, however; in the neighbourhood of Csákerény they appeared in large numbers and destroyed 70—80% of the clover and saintfoin. In spite of local damage, in the winter of 1937/38 the fodder situation continued to show a favourable trend.⁴⁸

A/4. Industrial crop production between 1928 and 1937

The sowing area of industrial plants produced for export purposes and for home industries was unchanged until 1928, then in the 1929 and 1930 crop-years it increased by about 50%. Although the labour-intensive nature of industrial plants would have made them profitable in the small-holdings, they were still produced mainly on large estates. Fejér County supplied the first comprehensive data on industrial crop production for the 1933/34 crop-year. According to these figures, the county was placed third in the country as regards production area, and sixth on the basis of yield averages:

linseed	1609 ha	13,059 q
rape seed	1273 ha	9,773 q
poppy seed	800 ha	3,371 q
hemp seed	40 ha	387 q
sunflower	33 ha	946 q

(H.S.R. 1935, 606—607).

Yield averages can only be deduced from the 1931 and 1932 data from the Előszállás estate of Zirc Abbey. In 1931 148.8 ha of the 11,495 ha total arable area of the estate was sown with rape, which yielded 26 wagons. The yield average was 17.5 q/ha, much higher than the 9.39 q national average. In 1932 166 ha of the estate was sown with rape; the yield was 19 wagons and the net average 11 q/ha. Even this poor yield was higher than the low (8 q) national average.⁴⁹

B) Grape, wine and fruit production in the 1928—1937 period

According to the 1928 survey, in Fejér County, which occupied the largest part of the Mezőföld, vine-growing was carried out in 98 villages and at Székesfehérvár:

vineyard area in the county	7,899 ha
vineyard area in Székesfehérvár	944 ha
grape juice yield in the county	107,977 hl
grape juice yield in Székesfehérvár	1,822 hl.

The county average for grape juice production was 13.7 hl, higher than the 8 hl national average (H.S.R. 1929, 34). In the following year the vineyard area was somewhat smaller: in the 98 vine-growing villages the cultivated vineyard area decreased to 7666 ha, and at Székesfehérvár to 621 ha by 1929. At the same time the grape juice production increased to 110,954 hl in the county and to 5580 hl in Székesfehérvár. This meant an average grape juice yield of 14.4 hl/ha compared to the national average of 12.3 hl/ha, which was also on the increase. The production area was reduced and the yield increased in the following year (1930) as well. In the 98 vine-growing villages in the county the vineyard area decreased to 7378 ha (at Székesfehérvár the size of the cultivated vineyard area did not change). At the same time the grape yield production in the county rose to 159,019 hl, and that in Székesfehérvár to 6338 hl. Thus, the average grape juice yield in the county rose to 21.6 hl/ha. The national average (18 hl/ha) also showed an increasing tendency (H.S.R. 1931, 28).

By 1931 the vineyard area in the 98 villages in the county became larger again (7577 ha), while in Székesfehérvár it remained unchanged. The severe drought in August 1931, the damage subsequently caused by hail, and the cold rainfall in September set back the production of grapes.⁵⁰ While the grape juice yield in the county fell to 128,877 hl, that in Székesfehérvár

⁴⁸ AMA-UTCA reports, January to December 1937.

⁴⁹ VCA, Zirc Abbey documents, 28—29.

⁵⁰ AMA-UTCA reports, August—September 1931.

increased to 13,500 hl. Thus, in comparison to the 17 hl/ha county average, the yield of grape juice produced in Székesfehérvár was 21.75 hl/ha on average. The national average was 20 hl/ha (H.S.R. 1931, 1101).

The summer of 1932 was unfavourable for the grape-vines. In June the vine-growing district of Mór (23% of the total area of the region) suffered 50–60% damage due to hail; then in August peronospora appeared in many districts. The farmers were seriously affected by the wine consumption tax introduced in October 1932. An annual tax of 30–36 pengős had to be paid for a vineyard of 0.20–0.25 ha, and this drove the vineyard owners to bankruptcy.⁵¹ The January frosts in 1933 did enormous harm to the vineyards and orchards. Hoarfrost broke off whole crowns of apricot, sour-cherry and plum-trees, and split the trunks of many trees in two right down to the ground.⁵² The law passed on brandy in January 1932 put the vine and fruit growers into a difficult situation. The local distilleries (that had previously bought up the wine for 0.14 pengős/litre) were closed down, and the purchasing agency functioned in Budapest only. Since the delivery and the borrowing of barrels cost 0.04 pengős/litre, only 0.06–0.07 pengős of the 0.11 pengős/litre purchase price (for 1 litre 10% proof wine of the 1928 vintage) was left to the grower. The distillation fee was also raised to 1.50 pengős/litre; as a consequence, many thousands of quintals of pressed grape skins and fruit went to waste in the small-holdings. The damage caused to the vineyards by hail-storms in July 1934 was generally around 30%, so the yield of that year was poor. The demand for wine also decreased, and the farmers could not sell what they had produced.⁵³ These problems resulted in reduced grape production. According to the 1935 surveys the vineyard area decreased to 6947 ha in Fejér County (1.8% of the total cultivated area), and to 519 ha in Székesfehérvár (4.3% of the total production area). Small-holders owned 3538 ha of vineyards (3.1% of their total production area) in Fejér County, and 188 ha (2.9% of the total area) in Székesfehérvár; second in order were the dwarf-holdings with a vineyard area of 2724 ha (7.2% of their total production area) in the county and 331 ha (16.6% of the total area) in Székesfehérvár. On the medium-size estates grapes were grown only on 318 ha in the county, excluding Székesfehérvár (0.5% of the total production area). On the large estates (again excluding Székesfehérvár) grapes were produced on a still smaller area; 367 ha, 0.2% of the total production area.

According to the 1935 survey:

57.9% of the vineyards were situated on hilly soils (4299 ha)

21.4% of the vineyards were situated on lowland (non-immune) soils (1586 ha)

20.7% of the vineyards were situated on lowland (immune) soils (1531 ha).

The distribution of the vineyard area (excluding Székesfehérvár) according to grape variety was as follows:

— European vines were planted on 69.9% of the area (5175 ha)

— vines grafted on American stocks were planted on 22.6% of the area (1693 ha)

— own-rooted American vines were planted on 7.2% of the area (534 ha).

The total annual yield was 177,407 hl, of which 160,523 hl was white wine, 10,885 hl rosée wine and 5999 hl red wine (H.S.R. 1938, 267, 271).

According to the data of the 1937 survey, 7465 ha of the 412,216 ha cultivated area of Fejér County was planted with grape-vines. Of the 58,984 farms in the county 23,040 were vine-growing farms. Their distribution by size was:

0.04— 0.33 ha	15,725 farms (2505 ha in total)
0.33— 1.15 ha	6,749 farms (3470 ha in total)
1.5 — 2.8 ha	463 farms (757 ha in total)
2.8 —11.5 ha	85 farms (445 ha in total)
over 11.5 ha	17 farms (288 ha in total)

(H.S.R. 1937, 627).

In Fejér County a fruit-tree census was first taken in 1935. The total number of fruit-trees in the county and in Székesfehérvár was as follows:

- peach 603,435 (36.2% of the total number of fruit-trees)
- apricot 218,890
- free-stone plum 142,206
- apple 131,275
- sour-cherry 119,510

⁵¹ AMA-UTCA reports, January to December 1932.

⁵² AMA-UTCA reports, January to December 1933.

⁵³ AMA-UTCA reports, January to December 1934.

- pear 101,283
- walnut 85,422
- cherry 77,970
- almond 62,239
- strawberry (bramble) 57,607
- other plum 57,437
- greengage 19,626

(H.S.R. 1938, I, 272).

C) Livestock farming in the Mezőföld between 1928 and 1937

C/1. Cattle breeding

The Hungarian cattle stock reached a maximum (2,663,000 cattle) in 1920, exceeding even the prewar level. This was followed by a rapid decrease in numbers, with some fluctuation, until 1928 (1,811,700). A fluctuating but gradual reduction could be observed in Fejér County too. The number of cattle rose from 77,000 in 1924 to 80,000 in 1925, then decreased again to 79,000 by 1928. Together with the cattle stock of 9951 in the Enying district, which then belonged to Veszprém County, the total number of cattle in the Mezőföld region was 88,951 in 1928.⁵⁴ While the national average showed a stagnation between 1928 and 1931 (GUNST 1970, 310), in the Mezőföld region the cattle stock increased during the same period. This increase amounted to about two thousand animals in the Fejér County districts and the Enying district combined. The following data of animal registration in 1928 and 1932 only refer to conditions in the Enying district:

	1928	1932
Total number of cattle	9,951	10,951
of which		
Simmenthal	7,890	8,907
bulls, total	226	209
breeder	94	94
cows	4,222	4,299
heifers	653	1,837
oxen	1,168	1,697
steers	1,621	865
other breeds	638	1,689
bulls, total	27	36
breeder	3	8
cows	298	903
heifers	126	302
oxen	120	328
steers	67	120
Hungarian breed	191	292
bulls, total	2	9
breeder	2	4
cows	20	86
heifers	5	19
oxen	137	159
steers	27	19
badger-coloured	106	63
bulls, total	15	3
breeder	3	1
cows	46	35
heifers	18	23
oxen	24	1
steers	3	1

The increasing numbers of bulls, cows and heifers were the sign of a coming depression (GUNST 1970, 312). The crisis of overproduction on the world market made its effect felt in

⁵⁴ Hungarian National Archives. Archives of the central civil authorities. Archives of the Ministry of Agriculture (AMA), General documents (K 184). Statistical sheets of animal registration. Veszprém County. Volume: 8594. Year: 1928. Henceforth abbreviated: HNA-AMA, Animal registration, 1928.

Hungary from January 1931. According to the report of the Előszállás estate of Zirc Abbey, from January 1931 the fattened cattle became unsaleable on the domestic market, and the Italian and Swiss markets were also very restricted. The Vienna market bought up only half of the contracted animals.⁵⁵ In spite of this the estate bought a further 188 steers for 42,534 pengős in 1931, and enlarged the stock of 884 draught-oxen by purchasing 46 draught-cattle (for 3292 pengős). The marketing problems were increased by the poor fodder crop in 1931. Owing to feeding difficulties (which arose in spite of the fact that 269 wagons of feed concentrates and 24 wagons of dried beet-slices were bought for 307,000 pengős) the annual volume of milk per cow fell from 2718 to 2579 litres on the Előszállás estate. So the 2,038,559 litre annual average for the estate dropped by 24,000 litres.⁵⁶ In autumn 1931 the declining purchase prices and the serious fodder deficiency forced the farmers to try to get rid of the animals before winter set in, so a cow could be bought for 50 pengős instead of the original price of 500 pengős.⁵⁷ The January and April reports for 1932 gave an account of farmers slaughtering sucking calves in some districts (Dunapentele), and of new-born calves being beaten to death in many places.⁵⁸ The farmers were discouraged from keeping animals when the Budapest milk marketing board reduced the purchase price of milk from 0.34 to 0.28 pengős in February 1932, and at the same time gave notice of the fact that milk purchase contracts originally valid until 1st January 1933 would be cancelled on 31st March 1932. From then on the purchase price of milk fell rapidly. In June 1932 milk delivered at Budapest was bought for 0.18—0.20 pengős/litre, while that sold locally fetched 0.12—0.14 pengős/litre, but by October 1932 the purchase price of milk fell to 0.04—0.06 pengős/litre.⁵⁹ In July 1932 an observer of the Upper Transdanubian Chamber of Agriculture proposed organizing cheap meat campaigns to give a new impulse to cattle farming: "... The meat campaign might consist of suspending all turnover taxes, duties, freight charges, etc. normally paid on the animals on certain days or for certain months. The slaughter cattle should be transported to the capital at no expense to the farmer, and should be officially weighed and distributed to the urban consumers at a price of 1.00—1.20 pengős/kg. If this were done in summer, by the time the cattle came in from grazing in autumn the stock would be reduced by at least 20—30,000 of the less valuable animals. So those left would be easier to keep in winter. This would improve the social situation, and raise the prices of animals as well."⁶⁰

The slow increase in the purchase prices of animals which began in spring 1933 and continued in the autumn of the same year renewed the interest of farm owners and estate managers in cattle breeding. Owing to the chronic shortage of fodder and the low purchase price of grain, from February 1934 the farmers fed their surplus produce to their animals.⁶¹ A fodder deficiency in summer caused a set-back again; the purchase prices of animals were reduced by 30%. By the end of 1934 cattle-breeding touched bottom. In Fejér County the number of cattle decreased to 76,000, 4000 less than in 1931 (GUNST 1970, 317).

In spite of a steady decrease in the purchase price of milk, the nearby capital, Budapest, notwithstanding the very low per capita milk consumption of 0.35 litres a day, represented a relatively stable outlet for the dairy farms of the Mezőföld. According to the 1934 surveys there were 72 dairy farms on large estates in Fejér County, with a total number of 4856 cows; two of these had more than two hundred cows each: the Hungarian-Dutch Agricultural Corporation (with 252 cows) and the Dréher estate at Szentlászló-puszta (with 206 cows). There were more than a hundred cows in each of 12 dairy farms (1486 cows in total), and a further 58 dairy farms were operated with a total number of 2912 cows (KECSKÉS 1981, 190—191).

After the low point in 1934 (the cattle stock of the country consisted of 1,677,700 animals) a slow, fluctuating progress began in cattle farming. This progress involved a certain degree of redistribution of the cattle breeds: red spotted cattle, a breed with relatively fast development, supplying more milk and meat and also suitable for use as draught-animals, became numerically dominant both nationally and in the Mezőföld (GUNST 1970, 321). According to the data of a national cattle census in 1935, the cattle stock of Fejér County showed the following distribution by breed:

⁵⁵ VCA, Zirc Abbey documents, 28.

⁵⁶ VCA, Zirc Abbey documents, 28.

⁵⁷ AMA-UTCA reports, December 1931.

⁵⁸ AMA-UTCA reports, January, April 1932.

⁵⁹ AMA-UTCA reports, June 1932, October 1933.

⁶⁰ AMA-UTCA reports, July 1932.

⁶¹ AMA-UTCA reports, February, October 1933; February, March 1934.

red spotted	70,419 animals
Hungarian-Transylvanian	6,642 animals
Simmenthal	6,003 animals
other breeds	1,917 animals
other Western breeds	1,672 animals
altogether	86,653 animals

(H.S.R. 1938, 274—275).

In 1936, due to feeding difficulties, there was a slight regression in cattle-breeding, then a slow rise in the purchase prices brought a slight upswing by 1937.

In 1936 77,863, and in 1937 76,853 cattle were registered in Fejér County.⁶²

Cattle farming was undoubtedly encouraged by the gradual evolution of cattle exports. From Fejér County a total number of 9570 cattle were sold abroad in 1937: 7193 to Italy, 1788 to Germany, 312 to Switzerland and 277 to Austria. The demand for slaughter animals showed the following trend:⁶³

— half-fattened oxen	Italy bought 5770
— fattened oxen	Germany bought 1129, Italy 850, Austria 230
— slaughter bulls	Italy bought 226, Germany 34
— fattened cattle	Italy bought 246, Germany 24, Austria 1
— lean oxen	Italy bought 38
— cattle less than 2 years old	Italy bought 71
— lean cows	Italy bought 3.

Besides the increasing export possibilities cattle-breeding was encouraged by the rising purchase price of milk, too. Some of the large estates surpassed the national average annual milk production per cow (3496 litres). In the dairy farm of the Előszállás estate of Zirc Abbey (902 cows) the annual milk production per cow was as high as 3563 litres.⁶⁴ By 1936—1937 the number of dairy farm in the Mezőföld increased considerably (79% of the total number of dairy farms in Hungary were found in Transdanubia); there were 91 dairy farms in Fejér County (46 of which worked on a co-operative basis), and in 1936 a total of 184,000 hl milk was bought up for processing and marketing purposes (H.S.R. 1938, I, 275).

C/2. Pig breeding between 1928 and 1937

Pig breeding was always the most hazardous of all animal breeding, since the feed situation, and consequently the health conditions, are factors which influence the number of animals from year to year to a considerable extent. The 1925—1928 period represented a zenith in pig farming: the pig stock reached 2,661,000 animals. In the five Fejér County and one Veszprém County districts of the Mezőföld the pig stock consisted of 172,300 animals in 1928, and showed an increasing tendency compared to the previous years. Comprehensive data on pig-breeding in the Mezőföld are not available for the period in question; animal registers have only been preserved for the Enying district (Veszprém County) for 1928 and 1933.⁶⁵ According to the registration data a total of 37,330 pigs were kept in the 15 villages of the district; 17,953 of these were lard-type ("mangalica") pigs, while 19,377 were meat-type pigs. The largest pig-stocks were found at Dég (3960 animals), Mezőszilas (2710), Enying (2427), Lajoskomárom (2341) and Lepsény (1526). The years 1929—1930 brought a further slow development (in opposition to the decreasing number of pigs nationally), particularly as regards the number of meat-type pigs.⁶⁶ Owing to the rapid decrease in grain prices from January 1931 the farmers used the superfluous grain supplies to increase the number of meat-type pigs. Pig-breeding, however, soon received a setback caused by the swine-fever which appeared in February 1931, first in the Sáregres district, and then at Lovasberény. Simultaneously, the low calcium content of the grain fodder resulted in rachitis cases among the pigs in the neighbourhood of Ercsi. By July more and more districts (Ercsi, Dunapentele,

⁶² Transdanubian Farmer's Library. No. 29. Report of the Upper Transdanubian Chamber of Agriculture to the 31st General Meeting on 12th May 1939. Győr, 64. (Henceforth abbreviated: TFL/29.)

⁶³ TFL/29, 73.

⁶⁴ VCA, Zirc Abbey documents.

⁶⁵ HNA-AMA, Animal registration, 1928.

⁶⁶ AMA-UTCA reports, December 1930.

Lovasberény) became affected by swine-fever, which caused 25–30% losses on average. By August mortality rose to 30–35%. Vaccination did not help. The farmers were of the opinion that the Pig Serum Production Corporation, having lowered the price of the serum owing to complaints, was producing an inferior quality serum. In December 1931, parallel with the epidemic, a catastrophic fall in the price of meat-type pigs occurred on the Budapest market, to which the panic-stricken farmers responded by trying to get rid of their animals. But there was no demand for them.⁶⁷ In 1932 the swine-fever continued to rage; a particularly dangerous epizootic centre was formed at Sáregres. Owing to the growing difficulties in purchasing fodder and litter the condition of the animals became worse and worse. In May 1932 the swine-fever caused a 30–80% mortality rate in the Nagylók district. In July the purchase prices for pigs rose somewhat, but the fodder shortage prevented the farmers from fattening them. The swine-fever culminated in September. In the Nagylók district 95% of the young pigs and the breeding stock perished, at Alcsút the pig stock belonging to the farmhands showed a mortality of 80%, while in the neighbourhood of Dunapentele and Felsőtörzsökpuszta there was a 90–100% loss. The situation was particularly serious in the Dunapentele district where, due to the high price of the serum, the epidemic broke out a second time in the course of the year.⁶⁸ The swine diseases caused losses on small-holdings and large estates alike. In the Előszállás estate of Zirc Abbey swine-fever broke out in a herd of 250, consisting of young cross-bred pigs purchased for fattening. In another cross-bred herd brucellosis appeared among the piglets: 305 of the 507 piglets died. In order to prevent the frequently occurring pneumonia the pig-sties were freed from dust and paved with bricks. It was impossible, however, to protect the pigs from spinal paralysis of tuberculous origin. To make up for the losses the estate purchased 400 young pigs for 56,218 pengős in 1932.⁶⁹ By 1933 the swine epidemics ceased. According to the inventory taken that year the number of pigs had been reduced everywhere. Detailed data are again only available from the Enying district (Veszprém County) of the Mezőföld (15 villages):⁷⁰

- in 1933 the total number of pigs was 26,565 (decrease compared to 1928: 10,765);
- the number of lard-type pigs increased (24,202), while that of meat-type pigs fell from 19,377 to 2363.

In consequence of a good grain crop in 1933 and a high maize yield in 1933–1934 the pig-stocks increased everywhere. In addition, from January 1934 the "Hangya" Co-operative raised the purchase price for pigs, giving 0.08–0.09 pengős/kg more than the traders, who were then forced to increase their prices. Since the grain prices were still low, many farmers continued to feed the grain to the pigs. That year the health conditions were also good; it was only at Sáregres and Rácalmás, the epizootic centre of the swine-fever, that a few milder cases of swine-fever occurred in March 1934. By April the mortality rate increased and the expensive inoculum remained ineffective. By December the swine-fever had reappeared in several districts (Mór, Rácalmás); a particularly large number of porkers perished.⁷¹ By April 1935 the feeding situation worsened again, and parallel to this, swine diseases appeared everywhere. Owing to the recurring epidemic the markets were closed and the animals became unsaleable. In August severe swine-fever broke out again in the Sáregres district which was the centre of the epidemic; the loss was 30–35%. By November the epidemic had spread to further districts: at Magyaralmás swine-fever killed 75% of the stock. To make matters worse, the fodder situation was more worrying than ever.⁷² In spite of the serious shortage of feed the epidemic ceased by February–March 1936. In August the swine-fever flared up again; at Lovasberény it killed 40% of the animals. At the same time, in the neighbourhood of Sáregres erysipelas was found among the young pigs and piglets.⁷³ The simultaneous inoculations for protection against fatal diseases, which were introduced in the second half of the thirties, did not bring about any significant improvement until 1938; the result could not be seen until later (GUNST 1970, 375).

The sharp reduction in the pig-stock can be characterized by the data for three years (Fejér County):

- 1935: 260,000 pigs; 13.3% of them meat-type (national average: 20%);
- 1936: 164,926 pigs;
- 1937: 162,171 pigs (H.S.R. 1938, I, 275; TFL/29, 64).

⁶⁷ AMA-UTCA reports, January to December 1931.

⁶⁸ AMA-UTCA reports, January to December 1932.

⁶⁹ VCA, Zirc Abbey documents, 28.

⁷⁰ HNA-AMA, Animal registration, 1933.

⁷¹ AMA-UTCA reports, January to December 1934.

⁷² AMA-UTCA reports, January to December 1935.

⁷³ AMA-UTCA reports, January to December 1936.

In 1937 the fodder situation was generally satisfactory everywhere, and the health conditions were better too. (Epidemics only occurred at Nagylók; brucellosis caused abortions in many cases.) Pig breeding was encouraged by the considerably increased demand and by rising purchase prices.⁷⁴

By 1938 the number of pigs in Fejér County became extremely high (207,000), which meant a 90% increase compared to 1924 (GUNST 1970, 363, 365).

C/3. Sheep breeding between 1928 and 1937

Sheep breeding is an extremely difficult branch of animal farming to assess. After the Great War (between 1920 and 1928) sheep breeding never reached the pre-war level. On a national scale for this period the sheep stock was the largest in 1925 (1,895,000), after which it decreased from year to year (GUNST 1970, 377—378). In Fejér County, as in all other counties of Transdanubia, the reduction was particularly great. The number of sheep fell from 112,000 in 1925 to 94,000 by 1928, and this decreasing tendency continued in the following years. No inventory of the animals was taken in 1928 for the whole area of the Mezőföld; only the registration data for the 15 villages in the Enying district (Veszprém County) are available, where a total number of 9014 sheep were reared.⁷⁵ Sheep flocks of considerable size were found in the following villages: Dég (2297), Mezőszilas (1658), Mezőkomárom (1493) and Enying (1263). No data are available for 1929 and 1930. According to the 1931 data, in Fejér County, i.e. in the largest part of the Mezőföld, the sheep population continued to decrease (to 87,000) compared to 1928. One of the main reasons for the decrease was the steady fall in the demand and price for wool. According to the reports, a new attempt to form a sheep farmers' association failed, and a number of district centres for washing and spinning the wool, planned for the summer of 1931, did not materialize either. The Upper Transdanubian Chamber of Agriculture suggested establishing a wool-sample depot in Budapest.⁷⁶ Owing to the permanent shortage of fodder and litter the sheep population decreased further in 1932, although the reports did not mention any epidemic diseases. The July 1932 report of the Upper Transdanubian Chamber of Agriculture explained the reduction in the sheep population: "... The big sheep-farms are selling this year's wool yield abroad (to England) for 1.40—1.60 pengős/kg. At the same time the medium-size sheep-farms can sell their wool for 0.80 pengős/kg, and the small farmers for only 0.60 pengős/kg on the domestic market. The average price is thus about 1 pengő, which is not even sufficient to cover the shepherds' wages in the sheep-farms. . . . The butcher pays 0.22—0.24 pengős/kg for sheep, including the wethers, and sells the mutton for 0.80 pengős/kg. . . . Wool pours in from abroad and not a single step is taken to protect the domestic producers. The districts should set up wool-washing plants and purchase spinning machines for the production of loose loden and firm worsted threads."⁷⁷ The reports for 1933 give an account of a year free from problems. Nevertheless, the sheep population continued to decrease everywhere: according to the inventory taken of animals in the Enying district the number of sheep was reduced from 9014 in 1928 to 7991 by 1933. Some of the big sheep-farms practically disappeared: that at Dég was reduced from 2296 to 666 animals and the sheep-farm at Mezőkomárom from 1493 to 768, while the Enying sheep-farm was completely liquidated; the sheep-farm at Mezőszilas stagnated (decreasing from 1658 to 1526), and only a single sheep-farm was established, with 4053 animals at Balaton-szabadi.⁷⁸

By 1934 sheep-breeding in Fejér County had touched bottom: the sheep population fell to 61,000 animals, which meant a reduction of 33,000 compared to 1928 (GUNST 1970, 383). Owing to the catastrophic situation, in January 1935 the Upper Transdanubian Chamber of Agriculture requested the government to stop buying wool from abroad and to supply the factories with Hungarian produce; at the same time they called attention to the fact that the 1.66 pengős/kg purchase price of wool did not even cover the production costs. (The price of 1 kg woollen cloth was 8.3 pengős.)⁷⁹

Since the fodder situation was relatively good in 1933—1934, in 1934, parallel to a numerical reduction in the fully developed sheep population, the number of young sheep considerably increased. According to the inventory taken in 1935, the sheep stock of Fejér

⁷⁴ AMA-UTCA reports, January to December 1937.

⁷⁵ HNA-AMA, Animal registration, 1928.

⁷⁶ AMA-UTCA reports, June 1931.

⁷⁷ AMA-UTCA reports, July 1932.

⁷⁸ HNA-AMA, Animal registration, 1933.

⁷⁹ AMA-UTCA reports, January 1935.

County consisted of some 80,000 animals, which exceeded the national average. 33.8% of the animals were felt-wooled sheep, 58.5% combing merino, 1.8% meat-type merino and 5.9% other breeds (H.S.R. 1938, I, 275). The year 1936 was again characterized by a serious fodder shortage, though without the parallel occurrence of epidemics. 1937 brought a good fodder yield, and the purchase prices also rose, yet the sheep population in Fejér County continued to decrease. The number of sheep was 70,082 in 1936, and 69,250 in 1937 (TFL/29, 64). The large number of progeny in 1934 and the good fodder situation in 1937 resulted in an increase in the sheep population of Fejér County by 1938. The sheep-stock reached 76,000, which, while it was a reduction of 18,000 animals compared to 1928, meant an increase of 15,000 in comparison to the 1934 minimum.

C/4. Horse breeding between 1928 and 1937

The horse stock of the country was considerably reduced during the Great War; the slow development after the war culminated in 1928, when the total number of horses in Hungary was 918,100. The trend of development was similar in Fejér County, where the horse stock increased from 32,000 in 1924 to 35,000 by 1928. In the following years the horse-stock showed a slow decline all over the country. It was only after 1938, under the influence of government measures taken because of the increasing war tension, that this tendency was reversed (GUNST 1970, 344, 349). Detailed data for 1928 are only available for the 15 villages of the Enying district (Veszprém County) of the Mezőföld. The horse stock of the district amounted to 4966 animals in 1928, 3704 of which were warm-blooded. There were no communal warm-blooded stud-horses, but 30 stud-horses and 100 colts were kept on private farms. The number of warm-blooded mares was 1837, and there were 1488 fillies and geldings. The number of draught horses was 1262. There were no communal draught stud-horses; but there were 14 stud-horses and 23 young stallions on private farms. There were 669 draught mares and 446 draught fillies and geldings.⁸⁰

In 1929—1931 the horse-stock of the county gradually declined. Owing to the unfavourable weather conditions in 1931 and the subsequent fodder and litter deficiency the horse stock in Fejér County decreased by a thousand animals between 1928 and 1931 (to 34,000). The problems of 1932 further reduced the horse stock of the county. According to the 1933 animal registers, in the Enying district (Veszprém County) of the Mezőföld the reduction in number (from 4966 in 1928 to 4836) was negligible; while the number of warm-blooded horses fell by 287 to 3417, that of draught horses rose by 157 to 1419. The increase in the draught horse stock was characteristic of Transdanubia: 64,000 of the total number of 73,000 mares were found in this region. In 1933 the situation for stud-horses hardly changed. There were only 9 warm-blooded stud-horses in communal management and 26 on private farms. (There were 54 young stallions.) The number of warm-blooded mares was 1735, while fillies and gelded horses numbered 1219. There was still a lack of communal draught stud-horses, though there were 8 on private farms. (There were 22 colts.) There were 685 draught mares and 563 fillies and geldings.

The decrease in the horse stock reached its lowest point in 1934, when the horse stock in Fejér County fell to 32,000. The year 1935 again showed an increasing tendency. According to the animal registers for that year the joint horse stock of Fejér County and Székesfehérvár was the following: total number of horses: 35,388, of which 24,796 were warm-blooded and 10,592 were draught horses. The distribution of warm-blooded horses by breed was:

English thoroughbred	274
Nonius	2,437
English halfbred	1,595
Arab thoroughbred	43
Lippizan	809
Arab	413
other warm-blooded breeds	19,225

Methodical horse breeding was promoted by the state stud-farms in Székesfehérvár and Kislér, which owned a total of 134 stud-horses; 48.5% of these were English halfbreds, 29.9% Nonius and 9% Arab halfbreds (H.S.R. 1938, I, 275).

Breeding did not go smoothly, however. In October 1936 the Upper Transdanubian Chamber of Agriculture was informed about problems arising in the Ráccreges district of the

⁸⁰ HNA-AMA, Animal registration, 1928—1933.

Mezőföld, since the maintenance of private stud-horses was not allowed and the authorities did not make arrangements for the provision of state-owned ones.⁸¹ The favourable weather and fodder conditions in 1936 and 1937 resulted in a slow improvement in horse breeding. The horse stock in Fejér County (excluding Székesfehérvár), which consisted of 33,134 animals in 1936 and 32,096 in 1937 (TFL/29, 64) rose to above 33,000 again in 1938. Some 44% of the horse stock was used for breeding (foals and geldings were exceptions).

Warm-blooded horses used for breeding:	10,003
including communal mares	9,780
communal stud-horses	32
private mares	180
private stud-horses	11
Draught horses used for breeding:	4,646
including communal mares	3,202
communal stud-horses	—
private mares	1,441
private stud-horses	3

(GUNST 1970, 355).

From 1937 onwards the price of horses rose considerably; the Ministry of Defence raised the price of two-year-old horses by 150%. At the same time, with a war policy in view, horse exports were first restricted, then in 1938, for military reasons, completely stopped.

4. The search for a way out of the economic and social crisis

As in 1920—1924, the government tried to find a way out of the economic and social troubles caused by the crisis, which were a breeding ground for leftist (communist) and rightist (national socialist) movements alike, through a land reform combined with resettlement. The political leadership at both national and county level unanimously emphasized from December 1936 onwards that this was the only way to solve the ever increasing economic and social problems. With this policy in view the Upper Transdanubian Chamber of Agriculture made surveys in 1936—1937 in Fejér County and elsewhere of the yield averages, production structures, production costs and net returns of the different landed properties. According to the data of the surveys:

On estates larger than 60 ha and based totally on wage-work:

income: 692 kg/ha wheat, equivalent to 131.50 pengős;
outlay: 673 kg/ha wheat, equivalent to 128 pengős;
net returns: 19 kg/ha wheat, equivalent to 3.50 pengős.

On landed properties of 12—60 ha based mostly on family work and only partially on wage-work:

monetary value of yield	112.50 pengős/ha
production costs	104.50 pengős/ha
net returns	8.00 pengős/ha

On holdings of less than 12 ha based totally on family work with no wage-work:

monetary value of yield	112.00 pengős/ha
production costs	100.00 pengős/ha
net returns	12.00 pengős/ha

(TFL/29, 89).

The calculations of net returns confirmed the opinion that the land reform should strengthen the peasant small-holders. The landless agricultural labourers and the dwarf-holders (most of whom were still in debt in 1936—37 for lands allotted more than ten years before) were automatically excluded from the redistribution of land. In the summer of 1937 the sub-prefect of Fejér County made concrete proposals on the execution of resettlement and land reform. Since the political power in the county was exclusively in the hands of the medium landowners, the latter suggested the state purchase and distribution of entailed

⁸¹ AMA-UTCA reports, October 1936.

estates and church lands. As a first step the sub-prefect proposed buying and distributing, in exchange for payment by instalments, the 17,000 ha Előszállás estate of Zirc Abbey, the 8075 ha entailed estate of Count Móric Esterházy at Csákvár, and the 2870 ha estate belonging to Aladár Zichy at Adony. According to the proposal the distribution of the three large estates would have given an impetus to economic development in 23 villages of the county. The manager of the church land concerned raised objections to the plan and succeeded in having it put off. The following year, in 1938, part of the 3600 ha Nádasdy estate at Nádasladány (1800 ha) was divided into small-holdings for tenant farmers. This was followed by the sellout of the Csekonics estate at Enying. The fact that this land, which was extremely suitable for intensive management, was bought by the Hungarian Radio and not by the peasants gave rise to a great scandal.⁸²

In the end, the resettlement and land reform policy came to nothing. It was only after the enforcement of Act XV/1942, following the 1938, 1939 and 1941 "anti-Jewish laws", that 67 tenants and landowners of the Jewish faith were forced to give up a total of about 12,000 h land in 37 villages of Fejér County (FARKAS 1970b, 128). Subsequently, 12,000 ha land in the Székesfehérvár district was also confiscated from Jewish landowners.

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AS I SEE IT...



FOREST POLICY IN THE HUNGARIAN PEOPLE'S REPUBLIC

The beginnings of Hungarian forest policy (forest management, timber industry and timber trade) took shape in the period following the Great War (1914-1918). After the downfall and disintegration of the Austro-Hungarian Monarchy, the Trianon Peace Treaty concluded with Hungary in the summer of 1920, which was unfortunate in concept and tragic in its long-term outcomes, declared the annexation of areas inhabited mostly by national minorities to the neighbouring countries.

As a result, the area of Hungary (excluding Croatia) was reduced from 28.3 to 9.3 million ha, the population from 18 to 7.6 million, and the forest area from 7.4 to 1.2 million ha. That is, a considerable proportion of the ceded areas were forested mountains. Forests of more or less local importance on the flatlands and hills of the present territory of Hungary earlier played a subordinate role in forest management and the supply of timber, serving primarily for the purposes of local wood supplies and hunting. The conifer, roundwood and sawlog requirements of the country were covered from the forests in the Carpathians. It is thus understandable that during the last century and at the beginning of the present century the forests situated on the present area of Hungary were managed even by the large forest estates as coppice stands producing fuelwood and small-size timber.

Conifers occupied 24% of the forest area of Hungary before the Trianon Peace Treaty, and a mere 4.1% in 1920. Consequently, after the Great War the total coniferous demand had to be covered by imports. Hungary, the country that had wood exports worth 58-70 million gold pengős* in the years preceding the Great War, became an importer of wood, placed fifth among the wood-importing countries of Europe. In the years following the Great War the value of the wood imports ranged between 30 and 150 million gold pengős, thus representing the largest proportion of the total imports.

This unfavourable situation in forestry awoke the conscience of professional foresters, particularly those with a progressive approach, and under the guidance of Károly Kaán, a well-known name in Hungarian forestry, who was then Under-Secretary of State, they elaborated a new forest policy. The most important items in this programme were the afforestation

* 1 US dollar = 3.379 gold pengős.

of the Great Plain, the reafforestation of wastelands, the replacement of clear-felling by natural regeneration and the legally enforced extension of systematic management to the whole forest area of the country.

This systematic forest management involved 20-year basic work-plans which ensured the sustained maintenance of forest resources by restricting the volume of wood felled so that it should not exceed the natural increment of the forest, and by requiring that cutting sites should be regenerated either naturally or artificially without the degradation of the soil. If forests are managed according to such work-plans, the forest and the wood will remain in all certainty an eternally renewable resource.

This modern forest policy conflicted in many respects with the interests of private forest owners. Therefore, under the conditions existing during the period between the two world wars, an increase in the forest area, and the reconstruction, technical and technological development, modernization and intensification of Hungarian forest management could only be carried out to a limited extent. During the period of economic stabilization there was some hope of progress but the economic crisis between 1929 and 1933 and the subsequent drift towards fascism and war shattered these hopes. Unfortunately, the counter-revolutionary system left a sad legacy behind it in the field of forest management, too.

The preconditions required for the establishment of up-to-date intensive forest management which would serve the public interest were created by the liberation of the country in 1945. The nationalization of the forests made it possible to bring about, step by step, a system of forest management that kept future interests in view. This was the first nationalization in Hungary, and the state-owned forest companies were the first large-scale state enterprises in the liberated country. Nationalization and the power of the working class created the necessary conditions for a planned economy. As a result, the top forestry management was able to set about elaborating a comprehensive concept corresponding to the given situation, with a view to the long-term development of forestry and the timber industry. This concept is best reflected by resolutions No. 1040/1954 on forestry production and No. 3009/1955 on the development of the timber industry and the economic use of wood, passed by the Council of Ministers. The original term of these resolutions was six years (1955—60), but the spirit in which they were conceived is still strong today.

In Hungary these resolutions were the first to summarize the socialist principles of forest management and primary timber processing and to specify the socialist order of forest production. The main objectives were:

- the reproduction of the growing stock on an increasing scale,
- the multipurpose utilization of forest resources,
- the mechanization (industrialization) of forest management, and
- the reconstruction and development of the timber industry in accordance with the wood supplies available in Hungary.

At the beginning of the fifties certain professional circles thought that reproduction on an increasing scale was feasible through the reduction of excessive felling and the extension of the forest area. When the Council of Ministers drew up Resolution No. 1040, how to achieve a sustained yield was the most hotly debated question. The representatives of the Forestry Department of the Ministry of Agriculture were of the opinion that about half of the 3.8 million gross cu. m. felled in 1953 could be felled annually on a long-term basis.

The main difference between the concept expressed in resolution No. 1040 and the former trend in forest management in Hungary was, that parallel with a further extension of the forest area, it urged the up-to-date intensive cultivation and regeneration of the existing forests, particularly the natural forests on hills and mountains, that played a decisive role in supplying the population with wood, and, as a joint effect of forest area extension and intensive cultivation, envisaged a gradual increase in the amount of wood felled. When determining the tasks of forest management the directives of Prof. M. E. Tkachenko, the great Soviet silviculturist, were kept in view: "... socialist forest management aims at increasing the productivity of the forests: to produce 2, 3, 5 cu. m. or even more good quality wood where only 1 cu. m. was produced before, and to increase all the other useful qualities of the forests in the shortest possible time. With this in view a passive relationship with the forest and elementary measures of forest protection must be replaced by a system of active measures aimed at altering the growing site and the forest stand itself; attention should be turned to the regular improvement of the soil and the microclimate and to the control of species composition and stand structure . . ."

It is generally agreed that silviculture, the systematic production of timber, can look back on a past of at most 100—200 years, and even this is only true of relatively few countries. Putting the emphasis on silviculture was undoubtedly a bold initiative at that time. Natural silviculture based on synecology tries to produce as much valuable timber over the long-

term as possible, while maintaining and tending natural, chiefly self-regulating, forest ecosystems and paying strict attention to environmental and landscape protection. This kind of forest management can be successfully applied on any site where the species composition and yield of the existing natural forests meet the demands. The silviculture of man-made forests employs agrotechnical practices to produce the maximum amount of wood from the tree species and types of timber required by the customers, while keeping all the other functions of the forest in view. This method is used where primary forest ecosystems have not survived, or where the species composition and yield of the forest do not meet the demands.

The programme of lowland afforestation has been extended into a national afforestation programme and developed further on an up-to-date ecological basis. As regards the ecological conditions, at the turn of the 18th and 19th centuries the natural environment was still relatively ideal in Hungary, but the subsequent extensive deforestation and regulation of water-ways (river and flood control) changed it rather unfavourably by the time of World War II. During the first Five-Year Plan period the environment began to change for the better as the result of widespread forest plantation and afforestation and the development of water management (irrigation). As far as the distant future is concerned, the aim is to approach the forest conditions at the turn of the century. The natural environment should be improved in such a way that the forests, together with the arable land, forest belts, water reservoirs and irrigated areas, form a systematically evolved, optimum landscape structure. In this case afforestation and water management will both serve the development of agriculture and forestry and the improvement of the natural environment and of human living conditions.

Table 1
Regional distribution of forest area

Year	Transdanubia	Great Hungarian Plain	Northern Hungary	Total
	thousand ha			
1800	1878.7	329.5	557.6	2765.8
1925	591.6	180.6	318.6	1090.8
1938	598.6	189.1	318.3	1106.0
1946	607.7	199.1	317.4	1124.2
1950	619.9	245.0	301.0	1165.9
1955	644.0	315.3	298.1	1257.4
1960	665.4	343.0	297.8	1306.2
1965	729.9	376.8	314.8	1421.5
1970	745.5	366.6	358.6	1470.7
1975	743.6	438.0	363.7	1545.3
1979	764.0	459.3	370.7	1594.0

The results achieved are shown in Table 1 and Fig. 1, which show that the forest area increased by 15.2 thousand ha during the lowland afforestation programme from 1925 to 1938, and by 469.8 thousand ha between 1946 and 1979 within the framework of the socialist national afforestation programme. The greatest change occurred in the Great Hungarian Plain, where the forest area became 4.7% larger at the time of the lowland afforestation, and 130.7% larger during the national afforestation programme. Between 1946 and 1979 some half of the total area withdrawn from agricultural production in the strict sense of the word (arable land, grassland, orchards, vineyards) was planted with trees, thus increasing the forest area of the country. Agriculture and forestry are part of the same branch of the national economy. Therefore, the afforestation of lands that are not, and cannot rationally be made suitable for the cultivation of agricultural plants does not mean that they are withdrawn from agricultural production in the broader sense of the word. Of the new forests and afforestations, 134 thousand ha was established by state forest companies, 61 thousand ha by state farms, 119 thousand ha by co-operative farms and 126 thousand ha by other state organizations. The increasing share

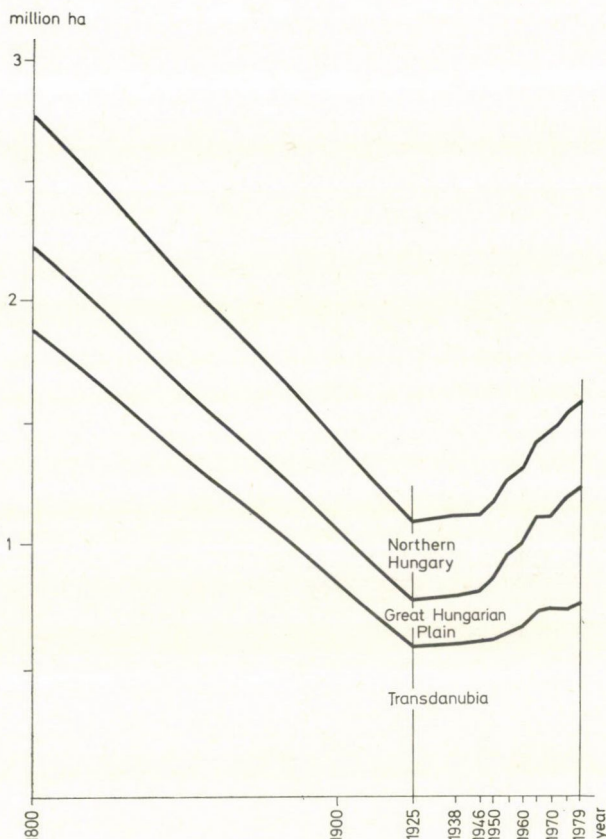


Fig. 1. Regional change in forest area in Hungary

of state and co-operative farms in forest plantations is a direct consequence of the development of agricultural production. As a result of the modernization and greater intensity of large-scale agricultural production, more and more land has become available for forest plantation, since, on the basis of a comprehensive survey on rational land use it could not be economically used for agricultural purposes.

When elaborating the development plan and determining the tree species to be grown, great importance was attached to the fact that Hungary is situated in the Central European deciduous forest zone. Accordingly it was planned to increase the area of oak stands and cut back that of Turkey oak, to plant fast-growing poplars and black locust wherever the site conditions were suitable, and finally, to introduce conifers wherever it was necessary for forest cultivation reasons or expedient for economic ones (KERESZTESI 1956). The results are shown in Table 2.

As can be seen, the area of beech and hornbeam stands did not change, the Turkey oak stands became slightly smaller and the area of other deciduous species (oak, black locust, poplars) and conifers increased. The area afforested with these latter tree species almost exactly equals the increase in the total forest area of the country.

This change in the species composition is extremely positive. It is an important result that the area occupied by beech remained unchanged and that of Turkey oak was slightly reduced. The considerably increased area of oaks, poplars, conifers and black locust is a great success.

In Hungary the breeding of forest tree species began around 1930 and has made considerable progress since 1950, when the Forest Research Institute was reorganized. The National Council for Agricultural Variety Testing has so far certified the following forest tree species

Table 2
Distribution of tree species

Tree species	Area covered by forest stands		Changes between 1948 and 1980	
	1948	1980	increase	decrease
	thousand ha			
Oak	283.2	339.4	56.2	—
Turkey oak	191.9	179.5	—	12.4
Beech	101.3	99.3	—	2.0
Hornbeam	102.3	103.0	0.7	—
Black locust	199.1	268.5	69.4	—
Poplars	33.8	156.9	123.1	—
Other deciduous species	87.6	118.4	30.8	—
Conifers	67.5	204.6	137.1	—
Altogether	1066.7	1469.6	417.3	14.4

- *Pinus silvestris* L. (Scotch pine) 'Cikota 1' (1974)
- *Populus alba* L. × *P. grandidentata* Michx. (white poplar hybrid) 'Favorit' (1977)
- *Populus* × *euramericana* Guinier (black poplar hybrids) 'I-154' (1978), 'I-214' (1972), 'Mari-landica' (1972), 'OP 229' (1972), 'Robusta' (1972), 'BL' (1980), 'Blanc du Poitou' (1980), 'Pannonia' (1980)
- *Robinia* × *ambigua* Poir. (black locust hybrid) 'Rózsaszín' AC (1973)
- *Robinia pseudoacacia* L. (black locust) 'Appalachia' (1979), 'Császártöltési' (1979), 'Jász-kiséri' (1979), 'Kiskunsági' (1979), 'Nyírségi' (1973), 'Pénzesdombi' (1979), 'Zalai' (1973)
- *Salix alba* L. (white willow) 'Bédai egyenes' (1972), 'Csertai' (1972), 'Pörbulyi' (1972), 'I-1/59' (1972), 'I-4/59' (1980).

The following supplies of planting material can be expected from the above listed state certified varieties during the sixth Five-Year Plan period:

	Total demand for planting material	Improved
	million/year	
Poplar	7	7
Willow	4	3
Black locust	20	8
Scotch pine	70	52
Austrian pine	25	1
Norway spruce	12	5
Other conifers	2	1
Altogether	140	77

In accordance with the provisions of the government decree on forestry development, in 1956 a team of professionals elaborated a new system of silviculture, based on the analysis of a ten-year large-scale experiment in a mixed forest of hornbeam and oak at Sárvár. The aim of the system was to produce thick, valuable wood assortments in the shortest possible time, to improve the quality of the final yields, and, with regard to the more distant future: to produce a growing stock superior to the existing one.

Before 1945, in the mostly privately owned Hungarian forests, timber growing and tending operations were carried out neither regularly nor skilfully. As far as thinning was concerned the old German system was followed: the under story was thinned and a closed canopy was carefully maintained, while only the underdeveloped, suppressed, twisted, sick trees were cut.

Once it was specified that the superior stems (V-trees) should be selected and maintained until the final cut, a fundamental change took place in forest thinning. Thinning has become a purposeful activity aimed at achieving a preconceived objective, in the course of which stems to be maintained until the final cut are selected, i.e. systematic, positive mass selection is carried out. Future thinnings are all carried out in the interests of the main crop which will be maintained until the final cut.

Putting into practice the new system of timber growing and tending involved a considerable increase in the intermediate yield (Fig. 2). The highest result was attained in 1960, when the intermediate yield made up 47.8% of the total fellings.

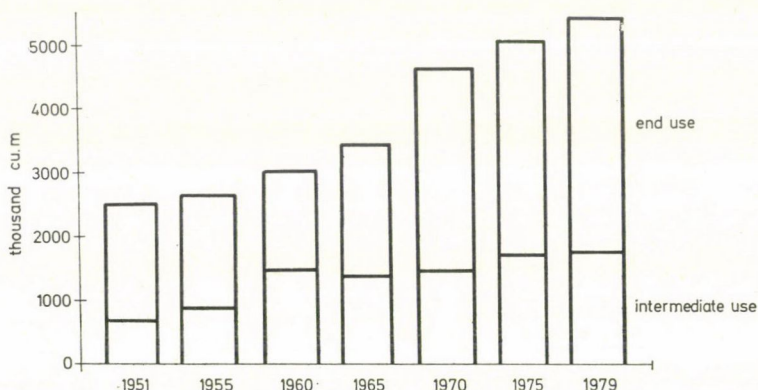


Fig. 2. Distribution of felling according to the cutting method in the state forests (gross cu. m. without stumps)

Regeneration cutting, which facilitates the natural regeneration of the forest from naturally fallen seeds and the preservation of forest populations and ecosystems evolved over thousands of years, was hardly practised in privately owned forests before 1945. The growing stock was usually regenerated by raising residual stands after clear-felling, or by sowing and planting saplings. The practice of natural regeneration from seed was ordered by the 1954 government decree on forestry development. The results are shown in Fig. 3.

The figure can be divided into two distinct periods (1951—1960 and 1965—1979). The first period was taken up by eliminating the war damage and making up for arrears in regeneration (areas cleared but not replanted). The second period, on the other hand, was marked by systematic forest management, when the volume of fellings gradually increased, and the regenerated area showed a constant increase. The whole three-decade period was characterized by artificial forest regeneration. As for the other two methods of regeneration, the following can be said. Regeneration from sprouts, which was significant in the first period, was successfully reduced in the sixties, and natural regeneration gained ground to an increasing extent. The latter culminated at the end of the fifties and throughout the sixties. At that time all the necessary means were available (money, labour force, experienced felling foremen, machines and transporting facilities for the careful felling and hauling of timber). The economic reform no longer ensured the conditions experienced during the 15—30-year period of natural regeneration; the emphasis laid on the annual profit did not favour it, and the game stock, which by far exceeded the natural game-keeping capacity of the forests, caused serious damage to the

natural growth of seedlings; as a consequence of all this, the practice of coppice cultivation gained ground again.

The multipurpose utilization of the forests is not a new idea. Man has been following this practice since ancient times. People living in big cities and enjoying the achievements of modern technology easily forget man's one-time dependence on forests. Economic development does not, however, lessen the wood demands of society. Even at the highest level of development wood remains an essential raw material for the building industry, and for furniture and paper production. In the decades to come wood may become a raw material for the production of liquid fuel or a substitute for petrochemicals. The forests offer invaluable places of relaxation for urban dwellers, and the trees in and around the cities contribute to the development of a more pleasant environment. The forests play a unique ecological role, and are thus universal objects of welfare. Forest management must therefore be concerned with everything that the forest can offer. The modern, multipurpose utilization of forests was introduced in the national (state) forests of the United States at the turn of the century.

Although the main objective of forestry policy in Hungary for the last fifty years has been to make up for the shortage of wood and to reduce wood imports, a Forest Law as early as 1935 raised the need for multipurpose forest utilization. In the socialist system general welfare is a realistic objective: "It is hardly questionable that in building a socialist system one of the main objectives is to create the general material and intellectual welfare of the people as a necessary precondition of a society composed of versatily developed personalities living a really human life" (KULCSÁR 1980).

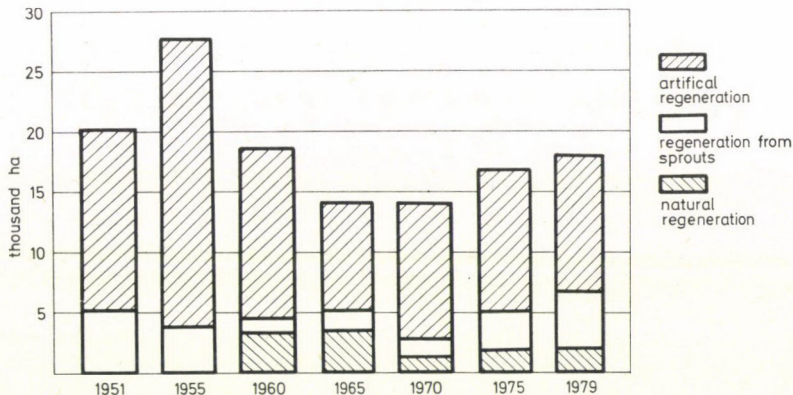


Fig. 3. Forest regeneration areas using various methods (first accomplishment, ha)

The basic components of welfare are the living standards, the life style and the surroundings, to which the forest and silviculture may contribute to a considerable extent. The book entitled "Hungarian forests, welfare forest management" (KERESZTESI 1971) summarizes the essence of welfare forest management as follows:

Besides the sustained, economical production of the largest volume of the highest quality wood and other forest products (fruit, honey, mushrooms, medicinal plants, etc.), welfare forest management consistently reckons with the non-material uses of the forest (silence, recreation, hunting, enjoyment of nature and landscape, etc.) and with the infrastructural services offered by the forest (the ecological role of the forest, its landscape-forming effect, environmental protection, recreation, etc.). In this concept the forest is more than a mere source of wood and other raw materials; it is a highly important part of the natural environment of man and should thus be tended and used according to the principles of multipurpose forest utilization. This type of forest utilization has the decisive advantage of enabling the forester in charge of the forest resource to meet the demands of the population at the highest possible level from the material, social and cultural points of view alike. At present foresters are still chiefly concerned with wood production. If multipurpose forest utilization is properly applied, it does away with this one-sided view and enables forestry to contribute more and more to the welfare of the population.

The main point of multipurpose forest use is that various forms of utilization take place simultaneously in one and the same forest; one of these is primary, but all of them are important, and wood production (growing and felling) can never be absent since this is the main function of the forest. In Hungarian forest management separate organizations have been brought into existence for double and triple-purpose forest utilization. In 1968 the Minister of Agriculture and Food ordered the organization of state forest and game farms through the amalgamation of state forestry farms (enterprises) and state-owned game parks (financed from the national budget) functioning on the same area. These are responsible for the co-ordination of the interests of forest and wildlife management and carry out up-to-date joint forest and game management on the same area. In the same year (1968) the Minister amalgamated the Pilis State Forestry, the Visegrád State Game Park and forests in Budapest which were previously managed by the Gödöllő Forestry to form the Pilis State Forest Park. The new establishment is designed to fulfil public welfare and cultural functions, and carries out up-to-date forest and game management, giving due consideration to landscape protection. This, in fact, means triple-purpose utilization.

In the course of preparing the National Forest Development Plan in 1974 a survey of forests allocated or intended for allocation primarily for environmental protection purposes (shelter belts, green belts, and forests established for soil, water, landscape or nature conservation) or for recreation and tourism (forests for relaxation, walks, excursions, camping; tourist and sports facilities) was made in other forestry enterprises, too. These are of the following size:

Primary purpose	1965	1980
	thousand ha	
<i>Wood production</i>	1305.4	1290.1
Recreation	6.3	54.9
Environmental protection	66.3	174.3
Nature conservation	4.5	24.0
Hunting	2.8	41.9
Experimentation	2.5	3.2
<i>Special-purpose forests altogether</i>	82.4	298.3
Total forest area	1387.8	1588.4

In 1965 only 6% of the total forest area was occupied by so-called special purpose or multipurpose forests, while in 1980 this figure had risen to 18.8%. The majority of these special purpose forests are aimed at environmental protection.

The labour shortage caused by increased industrialization and urbanization and the development of service industries after World War II, together with rising prices, the hard physical work required and the high production costs involved in forest management, urged the mechanization of forest operation and a gradual transformation on an industrial scale in almost all European and overseas countries. The application of modern techniques demanded the fast opening up of the forests by road construction. In Hungary this was initiated by Resolution No. 1040.

In the extensive forest plantations on the Great Hungarian Plain the use of Soviet caterpillar tractors, deep ploughs and planting machines rapidly spread. A considerable change has taken place in the equipment and methods used for felling and transport, the most difficult forestry operations. In felling, cross-cutting and debranching operations axes and double-handed crosscut saws have been replaced by chain saws. Besides skidding with horses, which was used almost exclusively earlier, tractors are now used to drag the logs to the roads, and trucks for further transportation. The mechanization levels of the most important operations in 1960/61, 1970 and 1979, respectively, are shown by the following data as a percentage of the total amount of work performed:

Forestry operations	1960/61	1970	1979
	mechanization %		
Soil preparation	43.0	43.3	58.8
Tree planting	1.0	23.0	33.3
Felling, cross-cutting	47.9	91.3	97.4
Debarking	0	24.1	54.6
Skidding (cu. m.)	4.9	19.6	59.7
Hauling and transportation (cu. m.)	47.4	83.0	97.5
Loading and unloading	0.9	21.3	66.4

The Resolution charged the National Forest Board with the preparation of a plan for the opening up of state-owned forests. The comprehensive plan for constructing up-to-date roads to exploit the forest resources of the country was a unique achievement even at an international level. The plan called for the gradual construction of a forest road system which would make it possible to perform intensive forest management over large continuous forest areas. In addition to the design of the whole road system and the preparation of the first 10–15-year plan of road construction, regional basic plans for forest exploitation dealt with the establishment of loading platforms at railway stations and wood processing units. On the basis of these plans annual road construction could be performed as an organic part of a uniform, planned system. In 1945 only about 200 km paved roads and 650 km earth roads were available. In the past 25 years a total of 1413 km paved roads, 1034 km earth roads and 89 km forest railroads have been constructed.

The initial forms of industrialization began to appear in forestry almost unobserved; these will eventually lead from a level of manual work, draught animals and craftsmanship to almost completely mechanized forest management. Forestry workers are being provided with an increasing amount of protection against the weather, physical strain and health impairment. An ever greater proportion of the work of loggers and planters consists of handling machines, so the resemblance to industrial workers is increasing. In the forest, however, they will always be exposed to mud and snow at the cutting sites, and the rigours of the weather will make their work hard for a long time ahead.

Cabinet resolution No. 3009/1955 on the development of the primary wood industry and on economical wood consumption ordered the modernization of existing sawmills and panel industry units and the initiation of fibre board and chipboard production, together with an economization on wood and the replacement of wood by other materials.

Up to the mid-sixties the technical conditions in the sawmills did not generally surpass the prewar level. At the beginning of the seventies a reconstruction of the furniture factories began, and light structures began to gain ground in the building industry, thus necessitating the modernization of the sawmills. The first phase of this modernization in the seventies only made up for the arrears of the past 25 years; an increase in the processing of wood from less valuable tree species and the up-to-date mass utilization of small roundwood cannot be expected until the second phase, due in the first half of the eighties.

In the developed industrial countries of the West fibre board and chipboard manufacturing has been extended with a view to utilizing coniferous waste wood. The problem of how to utilize small hardwoods (fuel wood) for this purpose was solved by Hungarian experts. After World War II this was the most important step towards the better industrial utilization of native timber resources. Fibre board and chipboard can be used in the joinery and carpentry industries to replace conventional laminated boards (plywood and strip board) as well as coniferous and beech sawn-wood.

The Fibreboard Factory at Mohács, which went into operation in 1959, is one of the biggest fibreboard factories in Europe; a considerable assortment of fibreboards is produced at a single site. First boards were produced from poplar and willow, and later from Turkey oak; today almost every kind of wood can be processed here.

Chipboard manufacturing was started at Szombathely in 1959 by West Hungarian Sawyers. Its successor, the West Hungarian Timber Company, the largest wood industry centre in Hungary, processes 200 thousand cu. m. firewood into chipboard. At the present

technical level firewood, forest chips, shavings and sawdust can all be used for making chip-board. In theory any tree species is suitable for this purpose. Besides the traditional chip-boards, mostly used for furniture manufacturing, the West Hungarian Timber Company has begun to produce cemented chipboards, used primarily in the building industry.

In the past quarter of a century the wood trade has become an integral part of forestry, and this has had a many-sided favourable effect on the development of forestry and the wood industry. When the management was centrally controlled the poor condition of the forests and the limited felling potential caused considerable problems in the wood supply of the rapidly growing economy. A solution to these problems was promoted by government approval of the national trade balance for major raw materials, including wood. The country's wood supply was put under the direction of the Chief Forestry Administration. In 1956 the Forestry Administration, as the actual manager of wood supplies, suggested adjusting the price of wood products to world market prices. Since forestry, the primary wood industry and the timber trade all came under the same authority, this ensured the most economical processing, marketing and utilization of native and imported wood. After the economic reform in 1968 fundamental changes occurred in the national system of forest management. The earlier centralized economy was replaced by a less restricted multichannel system. Users can now buy the required goods wherever they can get them at the most reasonable price. Forest companies were amalgamated with the saw-mills and board-producing units operating in their areas (forest and wood processing state farms). The new companies rapidly developed their wood industry and timber trade, thereby achieving a considerable improvement in their results. By that time the golden age of forest silviculture cultivation also yielded fruit; the felled volume could be increased considerably, even the exports of deciduous wood could be started. The imports of wood and wood products have increased from 2.7 to 4.7—5.7 million cu. m. over the last 25 years; however, in consequence of the industrialization of the country the share of wood imports within the total imports has fallen from 11.3% to 4.1%. During the same period Hungarian wood exports increased from 0.1 to 1.5 million cu. m., so the proportion of wood within the total exports rose from 0.5% to 1.1%. The quality, size and packing specifications for wood exports contribute to the technical development of the exporting firms. Within the framework of the work plans, wood exports stimulate a maximum increase in exploitation and help in purchasing the necessary machinery and equipment.

The years preceding the passing of resolution No. 1040 were a period of successive reorganizations. The organization system set up in 1954 proved suitable for the execution of the government resolution. It covered the development, direction and supervision of forest and game management and of the primary wood industry, and the whole state administration of the sector. The system helped forestry and the primary wood industry to gain and stabilize their due place and role in the national economy, and functioned successfully for some fifteen years, without any essential change, providing the organizational framework for undisturbed professional work and dynamic progress.

In April 1967 the Food and Agriculture Organization (FAO) of the United Nations Organization held a World Conference in Canberra, Australia, on man-made forests and their industrial importance. Man-made forests are defined as forest stands obtained as the result of new forest plantation, the transformation of the forest structure or artificial forest regeneration (the establishment of a forest stand identical to that removed). The conference also gave a definition of natural forest regeneration. In this context it is worth noting that growing stocks of exotic plants are regarded as artificial stands for 250 years after their introduction, even in the case of natural regeneration. The conference stated that most of the existing artificial stands were established over the past 50—60 years in the temperate zone, and over the past 20 years in the tropics. This means that the history of systematic silviculture covers a period of less than a hundred years.

170 delegates from 41 countries attended the conference, and a total of 104 papers were presented. According to data from questionnaires sent out by FAO the area of man-made forests was about 34 million hectares in 1965; an estimated 55 million ha was added to this, meaning that a total of 89 million hectares of forest stands were established by 1965 (Table 3). From a regional point of view, it is noteworthy that so far man-made forests have only played a significant role in forest management in Europe and Asia.

Table 4 lists those countries in which man-made forests cover half a million hectares or more. It can be seen that the joint area of artificial stands established by these 17 countries amounts to some 80 million hectares (90% of the total area). The most important silvicultural results have been attained by these countries. According to the incomplete data on the distribution by species group, conifers represent 77% of the forest plantations. The countries are listed in order of the proportion of man-made forests within the total forest area of the country. At the head of the list, together with Great Britain, stands the economically moderately

Table 3

Man-made forests in various regions according to the 1967 FAO data

Region	Forest area	Man-made forest			Proportion of man-made forests in the total forest area
		in the data-supplying countries	in other countries, estimated area	total	
		million ha			
Africa	568.00	1.71	0.5	2.21	0.4
Asia	540.99	12.15	30.8	42.95	7.9
Oceania	145.10	0.77	0.0	0.77	0.5
Europe	143.08	7.00	4.6	11.60	8.1
Latin America	1060.90	1.47	0.1	1.57	0.1
Near East	140.85	0.05	0.1	0.15	0.1
North America	616.27	10.65	0.0	10.65	1.7
Soviet Union	929.59	—	18.88	18.88	2.0
Total	4144.78	33.80	54.98	88.78	2.1

developed Hungary. The period after World War II, in which this was achieved, is known as the golden age of silviculture among Hungarian foresters.

The potential of the man-made forests in Hungary are characterized by the COMECON data presented in Table 5. Dividing the calculated yield by the forest area the annual yield per ha is obtained; this is the following (in million cu. m.): 1.55 in Bulgaria, 4.76 in Hungary, 3.20 in the German Democratic Republic, 0.60 in Mongolia, 2.77 in Poland, 2.67 in Romania, 0.83 in the Soviet Union and 3.26 in Czechoslovakia.

How was it possible for two resolutions with an original validity of 6 years to be effective for a quarter of a century? In Hungary forestry education was traditionally acknowledged at an international level even before 1945. Hungarian foresters and forestry engineers were equipped with up-to-date professional knowledge, but it was extremely difficult to apply this knowledge due to the forest ownership conditions of the time. Resolutions Nos 1040 and 3009 presented an ideal model of the profession, truly reflecting its best conceptions and boldest aims. So they were welcomed with great enthusiasm by everyone in the profession. A great number of experts excelled in creative work in the fields of nursery tending, forest management, silviculture, harvesting, mechanization and factory construction.

Every outstanding professional achievement was noted and acknowledged, both morally and financially, by the Chief Administration of Forestry at the Ministry of Agriculture, as well as by the management of the individual forest companies. They were ready to promote talented young people with initiative, while asking the opinions and considering the advice of experienced forest engineers. There was a flourishing literature and regular reading was an inherent part of the work. The managers spent most of their time doing active professional work.

Another reason for the long-lasting effect of the two resolutions was the compulsory nature of the professional instructions, which were learned by the whole profession within the framework of a nation-wide training programme. Important professional manuals were published later too, but they were no longer compulsory and the extension training was not on the same scale.

All in all, Resolutions Nos 1040 and 3009 represented an important step forward, considering the given period and circumstances, and this was given due consideration in Act VII/1961 on forests and wildlife (e.g. it gave almost word for word the same definition of the aim of forest management); and this contributed in no small measure to the fact that the objectives formulated in these resolutions are still in effect. The balance of the last quarter of a century may be summarized as follows. As the result of intensive forest cultivation and an increased forest area the growing stock of forests intended for wood production purposes now exceeds 248 million cu. m., compared to the 125 million cu. m. estimated to have existed

Table 4

Man-made forest in the leading countries according to the 1967 FAO data

Country	Forest area	Man-made forests			Proportion of man-made forests within the total forest area
		coniferous	deciduous	total	
		million ha			
Hungary	1.39	0.14	0.86	1.00	71.9
Great Britain	1.76	0.91	0.36	1.27	71.9
China*	96.38			30.00	31.1
Japan	25.05	6.38	0.71	7.09	28.0
Bulgaria*	3.62			1.00	27.6
South Korea	6.69	0.48	1.15	1.63	24.2
South Africa	4.10	0.42	0.50	0.92	22.5
Italy	6.03	0.50	0.33	0.33	13.9
Poland	7.68			0.76	9.9
France*	11.60	0.98	0.12	1.10	9.4
New Zealand	7.36	0.43	0.03	0.46	6.3
Spain	26.70	1.49	0.11	1.60	6.0
U.S.A.	307.10	9.67	0.68	10.35	3.4
Soviet Union*	929.59	15.15	3.73	18.88	2.0
Indonesia*	121.18	0.14	1.14	1.28	1.6
India	68.95	0.02	0.93	0.95	1.4
Brazil	352.10	0.07	0.43	0.50	0.1
Total	1977.28	36.78	11.07	79.62	4.0

* Estimated.

at the end of World War II. If the stumpage price is taken as equal to the forest maintenance contribution, this has a monetary value of 94 thousand million Ft. In 1954 the management was concerned that the forests were being over-exploited, while now, 25 years later, we are not capable of felling the allowable yield.

A very brief survey of forest management over the past quarter of a century is given in Table 6.

Could any better proof be required of the execution of a forestry development resolution aimed at reproduction on an increasing scale?

Now, after 25 years, resolutions which will open a new period have been passed; the Chief Administration of Forestry at the former Ministry of Agriculture has been replaced by the Forestry and Wood Industry Office of the Ministry of Agriculture and Food. By laying stress upon the development of the primary wood industry, timber utilization and the wood trade, the new party and government resolutions are expected to enable the Hungarian wood industry to rapidly catch up with forest management, and then to stimulate and promote a further improvement in forest management. In elaborating the new concepts a thorough examination was made of which objectives of Resolutions Nos 1040 and 3009 should be retained and where improvements were necessary, thus ensuring the unbroken progress of forestry and the primary wood industry.

In the coming long-term development period dynamic wood production must be co-ordinated with the planned development of the wood-working industry. Large volumes of wood which meets the requirements of the wood industry must be produced. Increasing stress must be laid upon improved varieties. Greater attention should be paid to interactions between

Table 5
Forest resources of the COMECON countries
 (after A. F. Tsekhmistrenko—V. A. Feofilov 1979)

Country	Forest area			Area covered by forest, %	Calculated yield		
	year	total	state-owned		year	total	coniferous
	thousand ha				million cu.m.		
Bulgaria	1977	3.284	3,284	29.6	1975	5.1	1.2
Hungary	1977	1.575	928	16.9	1975	7.5	0.4
GDR	1977	2.690	1,709	24.9	1975	8.6	6.4
Cuba	1977	1.595	1,595	14.4	—	—	—
Mongolia	1977	15.219	15,219	9.7	1975	9.2	8.5
Poland	1977	8.577	6,988	27.4	1974	23.8	19.4
Romania	1977	6.149	6,148	25.8	1971	16.4	4.3
Soviet Union	1973	771.964	748,808	34.5	1977	639.3	404.5
Czechoslovakia	1978	4.515	4,327	35.3	1975	14.7	10.8

Table 6
Brief survey of forest management over the past quarter of a century

	1950	1975	1979
Forest area, thousand ha	1166	1545	1579
Growing stock, million cu. m.	117	238	248
Allowable cut, million cu. m.	3.1	7.5	8.2
Actual cut, million cu. m. (gross yield)	3.1	6.7	7.3
of which, industrial wood	0.9	3.1	3.5
Wood products, million cu. m.	0.8	3.2	3.5
Industrial wood consumption, million RWE cu. m.	2.6	7.2	7.1
Firewood (and charcoal) consumption, million cu. m.	2.4	2.1	2.4
Total wood consumption, net million cu. m.	5.0	9.3	9.5
Share of domestic production, %	54.7	59.5	63.9
Wood imports, million RWE cu. m.	2.9	5.6	4.7
Wood exports, million RWE cu. m.		1.5	1.5
Foreign trade balance of wood, thousand million ERFT	-0.6	-3.1	-9.6

RWE = round-wood equivalent.
 ERFT = exchange rate forints.

genotype, growing site and silvicultural methods, as well as to their effect on wood products delivered to the wood industry. The production of propagation material, afforestation, forest cultivation, exploitation and wood processing must be regarded as integral parts of a general economic activity. Technologies and machinery adapted to the peculiarities of the species and the site conditions and meeting the demands of silviculture should be developed and employed in practice. Working conditions have become more difficult in many respects than they were when the two resolutions were passed, but no doubt the profession will again unite for the achievement of these inspiring new objectives, which are to the benefit of the whole society

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RECENSIONES

Agrotecnia de Cuba, 1978. 10, 2.

The journal contains 15 publications which deal primarily with the characteristics of pineapple, mango, tomato and citrus fruits (ripening process, quality, irrigation), with the bacterial diseases of certain plants, e.g. banana and maize, with the yields of various crops, and with fertilization as a factor influencing yield.

"Effect of ethephon (2-chloro-ethane-phosphoric acid) on the ripening process of the Red Spanish variety of pineapple (*Ananas comosus*)" by Concepción Díaz, Miriam Nuñez and Maria Bubarova.

The heterogeneity of the ripening process of pineapple is one of the greatest problems faced by the producing countries, including Cuba, where the Red Spanish variety of pineapple is grown on the largest area. The heterogeneity of ripening makes it difficult to harvest the pineapple either by hand or mechanically, since the harvesting work cannot be organized according to area. It therefore seemed necessary to test several chemicals aimed at favourably influencing the ripening process.

Ethephon has lately been used in experiments and it has been concluded that apart from various physiological effects it also has an influence on plant growth, flowering and fruit ripening. Satisfactory results have been obtained, for example, in the case of mango, coffee, tomato and citrus fruits.

The authors used various amounts (500, 750 and 1000 ppm) of the chemical in question and recorded its effect on fruit ripening. In the course of their studies they paid attention to various factors, particularly to the colour and quality parameters of the fruit (acid content, pH, sugar level, reducing substances). They noticed, among other things, a variation in external fruit colour compared to the homogeneity of the control.

They also found that higher concentrations of ethephon decreased the resistance and quality of the fruit. On the basis of their results they think it is possible to make the ripening process of pineapple homogeneous with the application of ethephon.

"Study of biological phenomena in the mango (*Mangifera indica*) varieties Haden and San Felipe" by Maria M. Hernandez, J. C. Sotolonge and S. Velazquez.

If large yields are to be attained the first thing necessary is to acquire detailed knowledge of the growth characteristics of the mango-tree. Consequently, the authors present information on the relationship between the successive phases of development and on the influence of climatic factors.

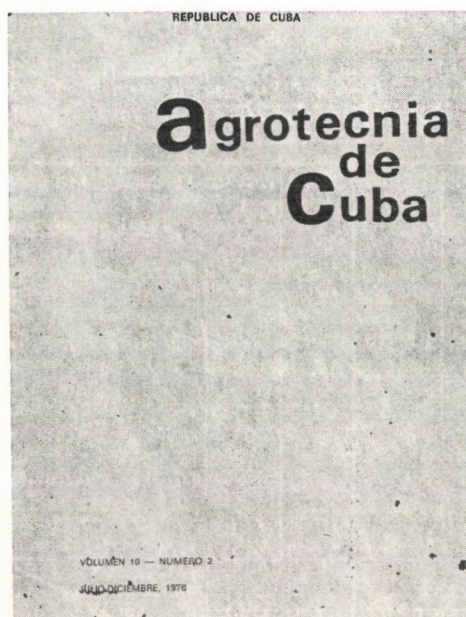
In 1973 and 1974 they studied the mango varieties Haden and San Felipe in order to become acquainted with the behaviour of the plant under given conditions.

They chose ten year old trees as the subject of the study, on an unfertilized area.

In both varieties uneven growth was observed in July and August, i.e. in the rainy season when the temperature was high. In December, January and February, when rain is scarce and the temperature is lower, differences in flowering were observed.

"Effect of the pesticide 'metribuzin' on tomato, as a function of the date of application" by R. Labrada and F. Garcia.

The profitability of tomato growing is determined primarily by the growth of weeds. Among the herbicide agents selected for tomato metribuzin had already been tested; the authors studied its effect as a function of the date of application. They used 0.7 kg of the chemical on the 1st, 5th, 10th and 20th day after transplantation. In the course of their observations they examined the phytotoxicity of the chemical, recorded the yields and determined the diameters of the tomato fruits. On the edges of the upper leaves of



the plants necrotic spots were observed when the treatment was applied on the 20th day, but this disappeared within the next 30 days without affecting the yield. In the authors' opinion metribuzin can be applied 15–20 days after the tomato seedlings are transplanted.

"Optimum capacity of sprayers used for citrus fruits" by I. Sotolongo.

The capacity of the water-tank is determined by a number of factors. When a sprayer with a smaller volume is used, the efficiency of the time factor is low, which increases the costs of application. When, on the other hand, the capacity of the water-tank is increased, the cost of the equipment also increases. It is thus for economic reasons that the author studies the possibilities of attaining an "equilibrium".

The author demonstrates that all spraying equipment requires a definite size of water-tank depending on the prevailing conditions, to ensure the maximum productivity of the machine at minimum costs. The investigations are complemented by theoretical calculations contained in tables and illustrated by diagrams.

"Comparative studies on two new bacterial diseases in the banana-growing regions of Cuba" by N. R. Docando.

Bananas play an important role in the national economy of Cuba, not only as a commodity for domestic consumption but also as an export item. This plant requires

humidity, warm temperature and appropriate cultural practices and plant protection to produce satisfactory yields. In 1974 the Central Laboratory for Bacteriological Diagnoses isolated pathogens which adversely affected the yield on the banana areas of La Habana province. The disease was first observed on areas where it had never previously occurred. Samples were therefore taken and processed bacteriologically.

Yellow spots were first observed on bananas in La Habana province in 1974; the spots later became brownish with a darker centre. In other places in the same province the edges of the green leaves were necrotized, and when the plants were cut down a light-coloured fluid with a bad odour was found in the stem. According to the results of the author's bacteriological examinations the lesions, which appear in two different forms, are caused by *Erwinia chrysanthemi* and *Erwinia carotovora*, respectively.

"Yield reduction caused by tobacco mosaic virus in paprika and tomato" by T. F. Fernandez and R. Gáborjányi.

The tobacco mosaic virus attacks many groups of plants including paprika and tomato. The symptoms are the same: the plants are stunted and the leaves, flowers and fruits show necrotic spots and deformations.

The authors grew paprika and tomato in trial plots. The plants were experimentally inoculated with tobacco mosaic virus marked To77; the treatment was repeated on four occasions every week. In the course of the experiment the height of the plants, the number and weight of the fruits and the yield per plant were recorded. In the case of paprika the disease caused a 47% reduction in yield, while in tomato the yield reduction was 55%. A direct correlation was observed between the decrease in growth and the age of the plant.

Subsequent experiments were aimed at finding data on possible recuperation tendencies in the growth to counteract lesions caused by the infection.

"Bacterial rot in maize stalks" by A. J. Garcia and G. Monteanu.

In 1975 a serious form of a previously unknown maize disease was observed in Camagüey province, showing symptoms similar to those caused by phytopathogenic bacteria.

The infected plants developed dark green spots on the surface of the stalk, which became softer than the surrounding plant parts. When the stalk was cut the authors found rotting, disintegrating tissues which emitted a strong, unpleasant smell. On the basis of biochemical pathogenicity tests the bacteria isolated from the lesions were identified as *Erwinia chrysanthemi*.

"Bacterial destruction of soybean" by A. Albornoz.

Soybean has recently assumed importance as an industrial crop and source of nutrients. The plant is exposed to infection by many pathogens (fungi, bacteria) which adversely influence not only the germinative ability of the seed but the development of the plant too. Such a disease was observed in 1974 and 1975 in the provinces Pinár del Rio and Havana. The disease attacked the leaves, pods and seeds. On the basis of morphological, cultural, biochemical, serological and other characteristics the bacteria cultured from the infected tissues proved to be *Xanthomonas phaseoli*.

"Bacterium wilt of tomato and paprika" by M. Stefanova and Z. Amat.

In 1973 and 1974 wilting of tomato and paprika was observed on some areas of the provinces Pinár del Rio and Havana. Branching in the upper part of the plant and secondary root growth were the initial symptoms. The diseased plants later showed total wilting. A longitudinal section of the plant stalk displayed necrotic spots surrounded by a cream-like exudate. When samples taken from the lesions were subjected to bacteriological examination *Pseudomonas solanacearum* was isolated and this was found to be in a causal relationship with the lesions found.

Four further short articles deal with the fertilization of potato yields. Data are presented on the effects of nitrogen, phosphorus and potassium fertilizers in various soils. Information is also given on the influence of the phosphorus content of the soil on the yield of potato.

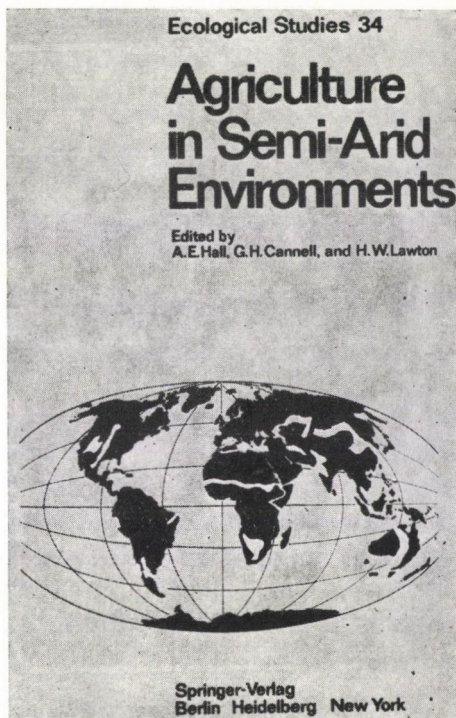
S. TUBOLY

HALL, A. E.—CANNEL, G. H.—LEWTON, H. W. (ed.) 1979: *Agriculture in Semi-Arid Environments*. Ecological Studies Vol. 34. Springer Verlag, Berlin—Heidelberg—New York. 1—340. 47 figures.

This book, containing 13 chapters written by 23 authors, is the first multidisciplinary survey of agriculture in the semi-arid zone of the world, a so far neglected area.

Besides describing the situation of agriculture the book gives a detailed characterization of the geographical and ecological conditions of the zone.

In the preface the authors emphasize that the "fragile" ecosystems of the semi-arid zone have substantially changed under the influence of human activity. There is an increasing demand to supply the growing population living in the area with a sufficient quantity of food.



These zones are harsh habitats for humans. The insecurity and unreliability of agriculture in the semi-arid zone was proved among other things by the famine in the droughty years of 1960—1970 in the so-called Saheli area in the northern part of Africa. In this region, even if the correct agricultural technology is applied, wide yield fluctuations must be reckoned with as a consequence of drought.

The agricultural production can be increased and stabilized by irrigation, as confirmed by Vol. 5 of this series (*Arid Zone Irrigation*).

On the relatively large semi-arid areas of the Earth, where the amount of precipitation is restricted and the water is not suitable for irrigation, a procedure known as dry farming is employed.

This book is aimed at presenting the available scientific results as a contribution to and assistance in the development of agriculture in semi-arid areas.

For up-to-date dry farming the results of investigations into climatology, soil microbiology and genetics, as well as the relationships between soil, plant and precipitation must be known.

The book is divided into the following chapters:

1. *Ancient Agricultural Systems in Dry Regions* (H. W. Lawton—P. J. Wilke)

In this chapter a large number of literary data are used to give a detailed survey of the evolution and development of agriculture in the semi-arid regions, and of the ancient agricultures in the Near-East (e.g. Mesopotamia), the African Continent, the Indian Subcontinent, the Soviet Union, China and the New World.

Some of the methods developed in ancient agricultural systems (dry farming, run-off farming, water harvesting, flood-water farming, irrigation farming) are still used in various parts of the world. A survey is given of the fodder and fibre plants already cultivated in the ancient agricultural systems.

2. *Development of Present Dryland Farming Systems* (L. Bowden)

The chapter describes the geographical conditions in Australia, India, Brazil, South Africa, the Sahel Region (the tropical semi-arid zone of North Africa), various systems of dry farming, and the possible methods of cultivation under the given climatic conditions. The author gives a survey of the so-called Mid-Latitude regions (certain areas of Eurasia and North America) which — in contrast to the frost-free semi-arid tropical regions — are characterized by the alternation of warm and cold seasons. A typical form of vegetation in this climatic zone is the steppe.

3. *Semi-Arid Climates: Their Definition and Distribution* (H. P. Bailey)

The well-illustrated chapter deals with the variability of the precipitation conditions in the semi-arid zone, and presents various humidity and aridity indices established on the basis of meteorological data.

The values of the indices provide a clear separation of the different provinces of the semi-arid zone of the Earth. The radiation, evaporation, precipitation and temperature data for the dry regions of the northern hemisphere are presented in tabular form.

4. *Agroclimatology Applied to Water Management in the Sudanian and Sahelian Zones of Africa* (C. Dancette—A. E. Hall)

The authors give an account of the results of agroclimatological investigations (evaporation losses from plant and soil) made in the northern part of Africa. The strategy for the coming years calls for co-operation between meteorologists, agroclimatologists, agronomists, engineers and administrators in elaborating, on the basis of the available research results, an adequate technology for the utilization of precipitation and underground

water supplies, as well as the water of reservoirs which will be constructed later.

5. *Microbiological and Biochemical Aspects of Semi-Arid Agriculture* (D. D. Focht—J. P. Martin)

This chapter discusses the microbiological conditions in the semi-arid regions, the effects of various factors (water, air, temperature, pH value), and their complex action on soil bacteria, algae and fungi. The organic matter content of the soil, the extent of decomposition and the rate at which the elements required for the mineral nutrition of plants are released, are of fundamental importance in agriculture.

6. *Crop Adaptation to Semi-Arid Environments* (A. E. Hall—K. W. Foster—J. G. Waines)

The authors describe the phenological and genetic criteria for the adaptation of plants to a semi-arid environment. When choosing what crops to grow the efficiency of water utilization (the ratio of water transpiration per unit time to the yield or dry matter production) must primarily be kept in mind.

Among the available genetic sources the chapter mentions various cultivated and wild forms of barley, wheat, millet, sorghum, maize, cowpea and bean, and the genotypes that are physiologically and morphologically adaptable to a semi-arid environment.

7. *Water Transport Through Soil, Plant and Atmosphere* (W. A. Jury)

This chapter discusses the components of the soil-plant-atmosphere continuum and the models that can be constructed to describe it. Numerous data are necessary for the models, including the motion of water in the soil, evapotranspiration, water uptake of plants, root density, the absorption function of the root, stomatal reaction and yield.

8. *Crop Management in Semi-Arid Environments* (W. H. Isom—G. F. Worker)

Two main categories (subsistence farming and commodity production) and a number of transitional forms of crop management in semi-arid regions are the subject of this chapter. The authors describe various methods of cultivation such as ley-farming, crop rotation, monoculture, mixed cropping and intercropping, and also discuss the technology of sowing (date and depth of sowing, fertilization, pest control, etc.).

9. *Soil Management in Semi-Arid Environments* (D. W. Henderson)

This chapter deals with the effect of soil cultivation on the moisture content, fertility, micro-environment and erosion of the soil.

10. Erosion and Its Control in Semi-Arid Regions (G. H. Cannell—L. V. Weeks)

On certain areas of the semi-arid zone the extent of erosion is alarming. This justifies the authors in determining the rates of erosion caused by different farming systems. They specify the factors that influence the extent of erosion by water and wind.

11. Diseases and Nematode Pests in Semi-Arid West Africa (S. D. Van Gundy—M. Luc)

The authors present a detailed description of ways of reducing the number of pests and the extent of damage (cultivation method, crop rotation, pesticides, resistant varieties, etc.). A survey is given of the most frequent plant and animal pests found on the major crops cultivated in semi-arid West Africa (sorghum, millet, cowpea, peanut).

12. Weed Control (L. S. Jordan—D. L. Shaner)

One of the main problems on agricultural areas is the loss of yield due to weeds. This chapter gives a survey of the characteristics, reproduction ability and life cycles of weed plants in semi-arid regions. The authors describe efficient methods of weed control (cultural practices, competition by cultivated

plants, proper crop rotation, mechanical and biological control, application of herbicides). An important part of the chapter is the description of the effects of herbicides on the soil and the environment. The herbicides which can be applied to different crops are summed up in a table.

13. The Interaction Between Cultivation and Livestock Production in Semi-Arid Africa (R. L. McCown—G. Haaland—C. de Haan)

This chapter discusses the interactions of cultivation, fodder production and livestock in relation to West Africa and provides an illustration of the complexity of agricultural systems in Africa.

To sum up, it can be said that this book gives an overall picture of the environmental conditions and agriculture of the semi-arid regions. The book focusses mainly on West Africa, a region for which little information is available. The chapters which discuss the agroclimatological, phytopathological and entomological conditions using West Africa as a model are fine examples of specialization and international co-operation.

M. Kovács

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INDEX

- J. Vörösbaranyi*: Effect of prolonged use of herbicides on the cellulose-decomposing activity of soil micro-organisms 257

VARIA I

- I. Óváry, É. Csonka, A. S. Koch, J. Nemes-Nagy, Z. Puskás, S. Fazekas, Z. Kosztolányi, É. Kádár*: Morphometry of monolayer tissue cultures III. Topologically adequate space of pixels as a supraindividual vista point 261
- L. Balla*: Regulation of the development of winter wheat varieties using long day illumination and high temperature 269
- E. Szücs, I. Molnár, Á. Wéber-Forgony, I. Szöllősi, L. Kishonti*: Effects of feeding milk from nipple-pails or buckets in calf rearing 273
- Z. Bedő, L. Balla, A. Ábrányi*: Inheritance of heading date in stem rust resistant wheat varieties, and disease escape 284
- F. Herdi*: Histological changes in the leaf of sunflower (*Helianthus annuus* L.) in response to 2,4-D treatments 288
- Á. Régius-Möcsényi, J. Várhegyi*: Mineral composition of some economically important grass species 297
- T. B. Szarvas, B. I. Pozsár, L. P. Simon*: Detection of endogenous, free formaldehyde in plants and its relationship with photosynthesis 313
- Zs. Lassányi, P. Tétényi*: Use of microphotometry for histochemical studies on the cell walls of laticifers in *Papaver somniferum* L. 330
- J. Dohy, I. Boda, Á. Kovách*: Data on the reduction in improving effect of A. I. bulls in relation to the genetic trend of the population 335

VARIA II

- A. A. Abd El-Hafez*: Inheritance of marker genes for leaf colour and shape in watermelon, *Citrullus lanatus* Thumb 343
- S. N. Maiti, P. Datta, S. R. Biswas, S. Sen*: A study of growth pattern in jute (*Corchorus olitorius* L.) 348
- V. P. Singh*: Inhibition of carotenoid biosynthesis in *Cucurbita pepo* L. cotyledons by Flurenol (EMD-IT 3233) 356
- V. Adinarayana, M. S. Gangwar, R. S. Sachan*: N, P and K requirement for targetted yields of potato (*Solanum tuberosum* L.) in Mollisol of Uttar Pradesh, India 359
- K. Srivastava, A. K. Randhawa*: Eco-physiological exploitation of triticale seeds with pre-sowing treatments to develop hardiness against moisture stress 362
- A. M. Ahmed, M. D. Heikal, M. A. Shaddad*: Changes in growth, photosynthesis and fat content of some oil producing plants over a range of salinity stresses 370
- B. P. Singh, B. A. Phillips*: Seasonal nodule activity profile of field grown soybeans 375
- M. R. Gabal*: Effect of N-doses, N-form and day temperature on nitrate accumulation in sweet peppers 377
- A. A. M. Abd El-Moneim*: Stimulative effect of heat treatment on germinative ability in annual *Medicago* species 387
- M. H. El-Sawak*: Influence of soil types, pre-sowing seed treatments, available amounts of soil nutrients and their combinations on tomatoes. II. Effect on mineral status of seedlings and leaf pigment contents 392

<i>N. Jaim, R. B. R. Yadava</i> : Effect of 2,4-dichlorobenzyl tributyl phosphonium chloride (Phosfon-D) on growth, flowering and yield of oat in a pot culture	401
<i>S. H. Mossa</i> : Observations on codling moth fecundity, egg production and longevity	406
<i>B. Sasmal, K. M. Sarkar, S. P. Banerjee</i> : Intergenotypic competition in jute (<i>Corchorus</i> ssp.)	411
<i>F. A. Salih</i> : Effects of row and plant spacing on kenaf yield and its components in the Kenana area of the Sudan	416
<i>B. R. Bakheit, E. Toth</i> : Results of resistance breeding on alfalfa I. Resistance to <i>Fusarium</i> wilt	424

FORUM

Our guest is Mr. Ferenc Donáth Former Under-Secretary of State at the Ministry of Agriculture of the Hungarian People's Republic (<i>Gy. Pál</i>)	431
---	-----

CHRONICA

<i>D. Cs. Veress</i> : The agriculture of the Mezőföld region in 1928—1937	437
--	-----

AS I SEE IT ...

<i>B. Keresztesi</i> : Forest policy in the Hungarian People's Republic	463
---	-----

RECENSIONES

<i>Agrotecnica de Cuba (S. Tuboly)</i>	477
<i>A. E. Hall—G. H. Cannel—H. W. Lewton</i> : Agriculture in semi-arid environments (<i>M. Kovács</i>)	479

INDEX

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